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**AERONAUTICS**

Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics.*

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For related information see also *34 Fluid Mechanics and Heat Transfer.*

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## ASTRONAUTICS

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**54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT** **3358**

Includes human engineering; biotechnology; and space suits and protective clothing.

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**55 SPACE BIOLOGY** **N.A.**

Includes exobiology; planetary biology; and extraterrestrial life.

## MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

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## PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

For related information see also *Engineering.*

**70 PHYSICS (GENERAL)** **3373**

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

**71 ACOUSTICS** 3375
Includes sound generation, transmission, and attenuation.
For noise pollution see *45 Environment Pollution.*

**72 ATOMIC AND MOLECULAR PHYSICS** 3376
Includes atomic structure, electron properties, and molecular spectra.

**73 NUCLEAR AND HIGH-ENERGY PHYSICS** 3377
Includes elementary and nuclear particles; and reactor theory.
For space radiation see *93 Space Radiation.*

**74 OPTICS** 3378
Includes light phenomena and optical devices.
For lasers see *36 Lasers and Masers.*

**75 PLASMA PHYSICS** 3380
Includes magnetohydrodynamics and plasma fusion.
For ionospheric plasmas see *46 Geophysics.* For space plasmas see *90 Astrophysics.*

**76 SOLID-STATE PHYSICS** 3381
Includes superconductivity.
For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**77 THERMODYNAMICS AND STATISTICAL PHYSICS** N.A.
Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.
For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

## SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

**80 SOCIAL SCIENCES (GENERAL)** N.A.
Includes educational matters.

**81 ADMINISTRATION AND MANAGEMENT** 3385
Includes management planning and research.

**82 DOCUMENTATION AND INFORMATION SCIENCE** 3385
Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.
For computer documentation see *61 Computer Programming and Software.*

**83 ECONOMICS AND COST ANALYSIS** N.A.
Includes cost effectiveness studies.

**84 LAW, POLITICAL SCIENCE AND SPACE POLICY** 3387
Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

**85 URBAN TECHNOLOGY AND TRANSPORTATION** 3387
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.
For related information see *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

## SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.
For related information see also *Geosciences.*

**88 SPACE SCIENCES (GENERAL)** N.A.

**89 ASTRONOMY** 3388
Includes radio, gamma-ray, and infrared astronomy; and astrometry.

**90 ASTROPHYSICS** 3388
Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics.*

**91 LUNAR AND PLANETARY EXPLORATION** 3390
Includes planetology; and manned and unmanned flights.
For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**92 SOLAR PHYSICS** 3391
Includes solar activity, solar flares, solar radiation and sunspots.
For related information see *93 Space Radiation.*

**93 SPACE RADIATION** 3392
Includes cosmic radiation; and inner and outer earth's radiation belts.
For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

## GENERAL

Includes aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs.

**99 GENERAL** 3393

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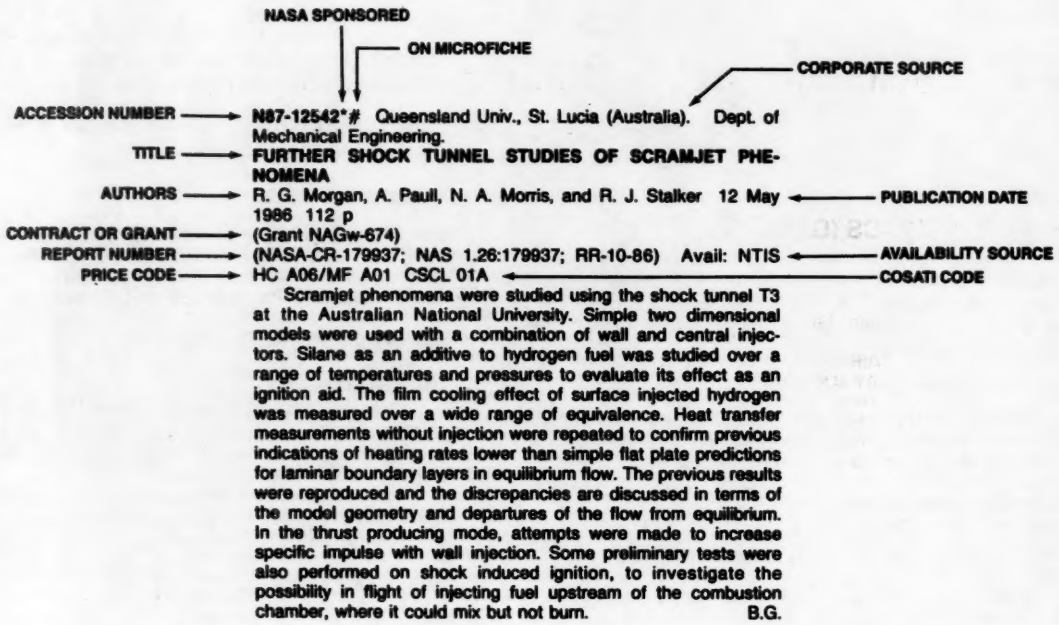
# TYPICAL CITATION AND ABSTRACT


NASA SPONSORED
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CORPORATE SOURCE
ACCESSION NUMBER
N87-12542*# Queensland Univ., St. Lucia (Australia). Dept. of Mechanical Engineering.
TITLE
FURTHER SHOCK TUNNEL STUDIES OF SCRAMJET PHENOMENA
AUTHORS
R. G. Morgan, A. Paull, N. A. Morris, and R. J. Stalker 12 May 1986 112 p
PUBLICATION DATE
CONTRACT OR GRANT
(Grant NAGw-674)
REPORT NUMBER
(NASA-CR-179937; NAS 1.26:179937; RR-10-86) Avail: NTIS
AVAILABILITY SOURCE
PRICE CODE
HC A06/MF A01 CSCL 01A
COSATI CODE
Scramjet phenomena were studied using the shock tunnel T3 at the Australian National University. Simple two dimensional models were used with a combination of wall and central injectors. Silane as an additive to hydrogen fuel was studied over a range of temperatures and pressures to evaluate its effect as an ignition aid. The film cooling effect of surface injected hydrogen was measured over a wide range of equivalence. Heat transfer measurements without injection were repeated to confirm previous indications of heating rates lower than simple flat plate predictions for laminar boundary layers in equilibrium flow. The previous results were reproduced and the discrepancies are discussed in terms of the model geometry and departures of the flow from equilibrium. In the thrust producing mode, attempts were made to increase specific impulse with wall injection. Some preliminary tests were also performed on shock induced ignition, to investigate the possibility in flight of injecting fuel upstream of the combustion chamber, where it could mix but not burn. B.G.

VOLUME 25 NUMBER 24 / DECEMBER 23, 1987

# Scientific and Technical Aerospace Reports

*A Semimonthly Publication of the National Aeronautics and Space Administration*

## 01 AERONAUTICS (GENERAL)

**N87-29404#** Washington Univ., Seattle. Dept. of Civil Engineering.
**GENERAL AVIATION AIRCRAFT UTILIZATION IN THE CONSTRUCTION INDUSTRY M.S. Thesis**
Gary W. Femling 1987 144 p
(AD-A183155) Avail: NTIS HC A07/MF A01 CSCL 05C

This research revealed that general aviation (GA) aircraft are a useful tool in the construction industry. Many construction companies employ aircraft in the performance of their daily operations and business. The following uses, in order of frequency of reported use, were: executive mobility, site investigation, personnel transport, parts and equipment expediting, photo and observation platform, and heavy lift operations. Of these, the first five fall generally in the construction support function while the last is the only direct construction operational use identified for GA aircraft. The type of projects for which aircraft are most often reported being used includes highway, dam and heavy earthwork projects. The predominant type of aircraft being used was the multi-engine airplane followed in frequency by the single-engine airplane and then the helicopter. GRA

**N87-29405#** Logistics Management Inst., Bethesda, Md.
**PROTOTYPE AIRCRAFT SUSTAINABILITY MODEL**
F. M. Slay and Randall M. King Mar. 1987 44 p
(Contract MDA903-85-C-0139)
(AD-A183183; LMI-AF601R2) Avail: NTIS HC A03/MF A01 CSCL 01C

This report describes the mathematical algorithms of a prototype version of the Aircraft Sustainability Model (ASM), a model designed to relate U.S. Air Force funding for reparable spares to aircraft sustainability measures. The ASM is a multi-echelon, multi-indenture inventory model that is unique in its portrayal of the transient effects resulting from a dynamic demand environment. Furthermore, the ASM is unique in its ability to simultaneously optimize spare requirements for multiple days of a conflict scenario. GRA

**N87-29406#** Federal Aviation Administration, Washington, D.C. Office of Management Systems.
**CENSUS OF US CIVIL AIRCRAFT, CALENDAR YEAR 1986 Annual Report**
31 Dec. 1986 316 p
(AD-A183423) Avail: NTIS HC A14/MF A01 CSCL 01C

This annual publication includes statistical data on the registered civil fleet, air carrier aircraft, and general aviation aircraft (both registered and active), detailed reports for general aviation aircraft by owner's state and county, and registered aircraft by make and model. GRA

**N87-29407#** Federal Aviation Administration, Washington, D.C. Office of Management Systems.
**FAA (FEDERAL AVIATION ADMINISTRATION) AIR TRAFFIC ACTIVITY FY 1986 Statistical Report, 1 Oct. 1985 - 30 Sep. 1986**
Nancy Trembley 30 Sep. 1986 230 p
(AD-A183624) Avail: NTIS HC A11/MF A01 CSCL 01E

This report furnishes terminal and enroute air traffic activity information of the National Airspace System. The data have been reported by the FAA-operated Airport Traffic Control Towers (ATCTs), Air Route Traffic Control Centers (ARTCCs), Flight Service Stations (FSSs), International Flight Service Stations (IFSSs), Approach Control Facilities, and FAA contract-operated control towers. GRA

**N87-29408*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**AN ANALYSIS OF REDUNDANCY MANAGEMENT ALGORITHMS FOR ASYNCHRONOUS FAULT TOLERANT CONTROL SYSTEMS**
Gloria J. Davis Sep. 1987 36 p
(NASA-TM-100007; A-87286; NAS 1.15:100007) Avail: NTIS HC A03/MF A01 CSCL 01B

Redundancy management algorithms, commonly referred to as voters, are algorithms used in fault-tolerant control systems to vote on incoming redundant data, isolate bad signals, and output a single good value. In a synchronous environment, this algorithm is a straightforward signal-to-signal comparison with relatively low complexity. The technology of asynchronous control systems, recently realized in the Ultrareliable Fault Tolerant Control System research program at NASA Ames Research Center, requires more complex algorithms for fault detection and signal selection. A variety of algorithms used for this process, a means of testing them, and their basic performance under a simulated environment of the ultrareliable fault-tolerant control system are presented. Author

## 02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

**N87-29409** ESDU International Ltd., London (England).
**CONTRIBUTION OF WING DIHEDRAL TO SIDEFORCE, YAWING MOMENT AND ROLLING MOMENT DERIVATIVES DUE TO RATE OF ROLL AT SUBSONIC SPEEDS, (Y SUB P)SUB GAMMA, (N SUB P)SUB GAMMA AND (L SUB P)SUB GAMMA**
Mar. 1985 8 p
(ESDU-85006; ISBN-0-85679-512-7; ISSN-0141-397X) Avail: ESDU

This Data Item #85006, an addition to the Aerodynamics Sub-series, provides a method that relates the values of the dihedral contributions to the rolling moment due to the rate of roll, which can be estimated from ESDU A.06.01.01. The method is based on simple lifting-line and strip theory assumptions and applies to subcritical Mach numbers in attached flow on straight tapered wings with taper ratio greater than 0.25, aspect ratio greater than 1.5, and quarter-chord sweep less than 60 degrees. Comparison between predicted and experimental results for one wing shows good agreement, and a practical worked example illustrates the use of the method. ESDU

**N87-29410** ESDU International Ltd., London (England).
**PITOT AND STATIC ERRORS DUE TO NON-STEADY FLIGHT**

May 1985 23 p
(ESDU-85011; ISBN-0-85679-517-8; ISSN-0141-4054) Avail: ESDU

The additional corrections to the pitot and static pressures, registered by their sensors in unsteady flight conditions, required to allow the use of the steady flight calibration are treated. The corrections arise because there is a lag in the transmission of a pressure change at the sensor ports to the instrumentation. That lag is caused by acoustic and friction effects in the airflow in the system when the pressures are changing but, for high performance aircraft, includes contributions from the inertia of the air mass in the pressure system in accelerated flight and, when the static ports are relatively small, a lag additional to that found in ground calibrations that is thought to be due to the flow through the ports themselves. Estimation methods are provided for each contribution to lag for use when measured values are not available, and allows corrections derived from ground (or flight) calibrations to be adjusted to apply to different conditions from those under which they were obtained. A practical worked example demonstrates how the methods are applied. ESDU

**N87-29411*#** United Technologies Research Center, East Hartford, Conn.
**AN ANALYSIS OF THE CROSSOVER BETWEEN LOCAL AND MASSIVE SEPARATION ON AIRFOILS Final Report**
M. Barnett and J. E. Carter Washington NASA Sep. 1987 107 p
(Contract NAS1-16585)
(NASA-CR-4096; NAS 1.26:4096) Avail: NTIS HC A06/MF A01 CSCL 01A

Massive separation on airfoils operating at high Reynolds number is an important problem to the aerodynamicist, since its onset generally determines the limiting performance of an airfoil, and it can lead to serious problems related to aircraft control as well as turbomachinery operation. The phenomenon of crossover between local separation and massive separation on realistic airfoil geometries induced by airfoil thickness is investigated for low speed (incompressible) flow. The problem is studied both for the asymptotic limit of infinite Reynolds number using triple-deck theory, and for finite Reynolds number using interacting boundary-layer theory. Numerical results are presented which follow the evolution of the flow as it develops from a mildly separated state to one dominated by the massively separated flow structure as the thickness of the airfoil geometry is systematically increased. The effect of turbulence upon the evolution of the flow is considered, and the impact is significant, with the principal effect being the suppression of the onset of separation. Finally, the effect of surface suction and injection for boundary-layer control is considered. The approach which was developed provides a valuable tool for the analysis of boundary-layer separation up to and beyond stall. Another important conclusion is that interacting boundary-layer theory provides an efficient tool for the analysis of the effect of turbulence and boundary-layer control upon separated vicsous flow. Author

**N87-29412*#** City Coll. of the City Univ. of New York. School of Engineering.
**AN INVESTIGATION OF THE FLOW CHARACTERISTICS IN THE BLADE ENDWALL CORNER REGION Final Contractor Report**
Birinchi K. Hazarika and Rishi S. Raj Washington NASA Jul. 1987 291 p
(Grant NAG3-122)
(NASA-CR-4076; E-3500; NAS 1.26:4076) Avail: NTIS HC A13/MF A01 CSCL 01A

Studies were undertaken to determine the structure of the flow in the blade end wall corner region simulated by attaching two uncambered airfoils on either side of a flat plate with a semicircular leading edge. Detailed measurements of the corner flow were obtained with conventional pressure probes, hot wire anemometry, and flow visualization. The mean velocity profiles and six components of the Reynolds stress tensor were obtained with an inclined single sensor hot wire probe whereas power spectra were obtained with a single sensor oriented normal to the flow. Three streamwise vortices were identified based on the surface streamlines, distortion of total pressure profiles, and variation of mean velocity components in the corner. A horseshoe vortex formed near the leading edge of the airfoil. Within a short distance downstream, a corner vortex was detected between the horseshoe vortex and the surfaces forming the corner. A third vortex was formed at the rear portion of the corner between the corner vortex and the surface of the flat plate. Turbulent shear stress and production of turbulence are negligibly small. A region of negative turbulent shear stress was also observed near the region of low turbulence intensity from the vicinity of the flat plate. Author

**N87-29413*#** Lockheed-Georgia Co., Marietta.
**PROPFAN TEST ASSESSMENT TESTBED AIRCRAFT FLUTTER MODEL TEST REPORT**
C. M. J. Jenness 20 Oct. 1987 102 p
(Contract NAS3-24339)
(NASA-CR-179458; NAS 1.26:179458; LG85ER0187; L86R1350) Avail: NTIS HC A06/MF A01 CSCL 01A

The PropFan Test Assessment (PTA) program includes flight tests of a propfan power plant mounted on the left wind of a modified Gulfstream II testbed aircraft. A static balance boom is mounted on the right wing tip for lateral balance. Flutter analyses indicate that these installations reduce the wing flutter stabilizing speed and that torsional stiffening and the installation of a flutter stabilizing tip boom are required on the left wing for adequate flutter safety margins. Wind tunnel tests of a 1/9th scale high speed flutter model of the testbed aircraft were conducted. The test program included the design, fabrication, and testing of the flutter model and the correlation of the flutter test data with analysis results. Excellent correlations with the test data were achieved in posttest flutter analysis using actual model properties. It was concluded that the flutter analysis method used was capable of accurate flutter predictions for both the (symmetric) twin propfan configuration and the (unsymmetric) single propfan configuration. The flutter analysis also revealed that the differences between the tested model configurations and the current aircraft design caused the (scaled) model flutter speed to be significantly higher than that of the aircraft, at least for the single propfan configuration without a flutter boom. Verification of the aircraft final design should, therefore, be based on flutter predictions made with the test validated analysis methods. Author

**N87-29414#** Sandia National Labs., Albuquerque, N. Mex.
**THE AEROTHERMODYNAMIC ENVIRONMENT FOR HOLES IN HYPERSONIC CONFIGURATIONS**
John J. Bertin, William J. Tedeschi, Albino C. Bustamante, and Eric W. Reece 1987 10 p Presented at the AIAA Aerodynamics Flight Mechanics Conference, Monterey, Calif., 17 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-003790; SAND-86-2875C; CONF-870830-2) Avail: NTIS HC A02/MF A01

Results that are presented in this paper were generated in a study that focused on determining the aerothermodynamic environment that results when the external flow over a configuration in a hypersonic stream encounters a hole in its surface. A numerical code has been developed to compute a two-dimensional, expanding shear layer and the inviscid/viscid interaction that occurs at the recompression face at the downstream end of the hole. Surface pressures and heating rates were measured in a wind tunnel test and compared to the computed values using this new technique. The results of these comparisons are satisfactory. DOE

**N87-29415#** Sandia National Labs., Albuquerque, N. Mex.
**PARACHUTE SYSTEMS TECHNOLOGY: FUNDAMENTALS, CONCEPTS, AND APPLICATIONS. ADVANCED PARACHUTE DESIGN**
C. W. Peterson and D. W. Johnson 1987 23 p Presented at the Parachute Systems Technology: Fundamentals, Concepts, and Applications, Munich, West Germany, 22 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-011634; SAND-87-1648C; CONF-8706165-1) Avail: NTIS HC A02

(DE87-011634; SAND-87-1648C; CONF-8706165-1) Avail: NTIS HC A02

Advances in high-performance parachute systems and the technologies needed to design them are presented in this paper. New parachute design and performance prediction codes are being developed to assist the designer in meeting parachute system performance requirements after a minimum number of flight tests. The status of advanced design codes under development at Sandia National Laboratories is summarized. An integral part of parachute performance prediction is the rational use of existing test data. The development of a data base for parachute design has been initiated to illustrate the effects of inflated diameter, geometric porosity, reefing line length, suspension line length, number of gores, and number of ribbons on parachute drag. Examples of advancements in parachute materials are presented, and recent problems with Mil-Spec broadgoods are reviewed. Finally, recent parachute systems tested at Sandia are summarized to illustrate new uses of old parachutes, new parachute configurations, and underwater recovery of payloads. DOE

**N87-29416#** Sandia National Labs., Albuquerque, N. Mex.
**PARACHUTE SYSTEMS TECHNOLOGY: FUNDAMENTALS, CONCEPTS, AND APPLICATIONS**
D. W. Johnson 1987 10 p Presented at the Parachute Systems Technology: Fundamentals, Concepts, and Applications, Munich, West Germany, 22 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-011722; SAND-87-1649C; CONF-8706165-2) Avail: NTIS HC A02/MF A01

In this paper, many different types of tests, vehicles, and data acquisition systems will be discussed. The types of tests used by parachute designers are only limited by the designers' imaginations. Since the paper is of finite length, some designers' favorite methods of accomplishing a certain objective will not be discussed. Any omissions are unintentional and are left to future discussions either formally or informally. DOE

**N87-29417#** Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
**CALCULATION OF PRESSURE DISTRIBUTIONS ON SUPERSONIC DELTA WINGS USING STAGNATION SOLUTIONS [BEREKENING DRUKVERDELINGEN OP SUPERSONE DELTA-VLEUGELS M.B.V. STUWPUNTS-OPLOSSINGEN]**
A. J. N. Vreenegoor and P. G. Bakker Nov. 1986 60 p In DUTCH; ENGLISH summary
(VTH-LR-484; B8707457; ETN-87-90223) Avail: NTIS HC A04/MF A01

The supersonic inviscid three-dimensional (3D) potential flow about a plane delta wing was investigated; a method which calculates pressure distributions on the wing surface was derived. The flow was considered as conical, and could be completely analyzed in one cross flow plane in which the conical potential F was defined. Power series expansions for F were derived; they are called conical stagnation solutions and they still contain parameters which can be chosen freely. By embedding the expansions in the conical flow pattern about the delta wing, the free parameters can be determined systematically. This matching precedure was applied to both sides of the delta wing, determing expansions for F on the compression and expansion side. Using this result, pressure distributions on the wing surface were calculated. The method is shown to be quite accurate. ESA

**N87-29418*#** Cleveland State Univ., Ohio. Dept. of Civil Engineering.
**ENHANCED MIXING OF AN AXISYMMETRIC JET BY AERODYNAMIC EXCITATION Final Report M.S. Thesis**
Ganesh Raman Mar. 1986 177 p
(Contract NCC3-49)
(NASA-CR-175059; NAS 1.26:175059) Avail: NTIS HC A09/MF A01 CSCL 01A

The main objective of acoustic excitation studies is to gain a high level of control over processes governing free shear flow characteristics. The basic premise is that inherent instability waves in free shear flows are excitable by external perturbations with frequencies close to the natural instability frequency of the flow. An 8.89 cm diameter axisymmetric jet was acoustically excited by four loudspeakers placed upstream of the nozzle exit. Measurements were made at Mach numbers of 0.435 and 0.2. A single hot-wire probe was used to obtain turbulence levels at the nozzle exit and along the centerline, and a microphone at the nozzle exit was used to study the resonance characteristics of the rig. A Pitot probe was stationed at X/D = 9 downstream along the nozzle axis to study the Strouhal number dependence and to look at threshold levels for excitation. The test results were obtained after a preliminary evaluation and facility improvement. Excitation at the correct Strouhal number enhanced mixing significantly. The effects were most prominent in the Strouhal number range between 0.4 and 1.0. The effects of acoustic excitation also depend considerably on the sound pressure level at the nozzle exit and were more pronounced at higher sound levels. Other factors which influenced the excitability were valve noise, exit turbulence levels, extraneous noise, and a flanged nozzle. Analysis of the hot-wire signal, in conditions of optimum jet mixing, showed vortex pairing to occur between 2 and 3 diameters downstream. Author

**N87-29419*#** Ohio State Univ., Columbus. Aeronautical and Astronautical Research Lab.
**TRANSONIC INTERFERENCE REDUCTION BY LIMITED VENTILATION WALL PANELS Final Report**
John D. Lee Jan. 1986 15 p
(Grant NAG3-109)
(NASA-CR-175039; NAS 1.26:175039) Avail: NTIS HC A02/MF A01 CSCL 01A

In two wind tunnels used for the two-dimensional airfoil tests, each wall above and below the model was modified by replacing small segments of the solid boundaries with perforated plates vented into sealed chambers. Perforated segments having approximately 40 percent open area were found to reduce the transonic wall interference to a negligible level, for a model chord-to-tunnel height ratio of 0.5. This report describes the physical arrangement and presents typical model pressure distributions to illustrate the effectiveness of the technique. Author

**N87-29420*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**CONTROL OF SHEAR FLOWS BY ARTIFICIAL EXCITATION**
E. J. Rice and K. B. M. Q. Zaman Oct. 1987 12 p Prepared for presentation at the 11th Aeroacoustics Conference, Sunnyvale, Calif., 19-21 Oct. 1987; sponsored by the AIAA
(NASA-TM-100201; E-3794; NAS 1.15:100201; AIAA-87-2722)
Avail: NTIS HC A02/MF A01 CSCL 01A

Investigations involving artificial excitation of various shear flows are reviewed. Potential applications of excitation in flow control, e.g., in enhancing mixing, and in delaying transition and separation are discussed. An account is given of the current activities at NASA Lewis Research Center in this regard. Author

**N87-29421*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**ESTIMATION OF BLADE AIRLOADS FROM ROTOR BLADE BENDING MOMENTS**
William G. Bousman (Army Aviation Research and Development Command, Moffett Field, Calif.) Aug. 1987 23 p Presented at the 13th European Rotorcraft Forum, Arles, France, Sep. 1987
(NASA-TM-100020; A-87311; NAS 1.15:100020; USAAVSCOM-TR-87-A-8) Avail: NTIS HC A02/MF A01 CSCL 01A

A method is developed to estimate the blade normal airloads by using measured flap bending moments; that is, the rotor blade is used as a force balance. The blade's rotation is calculated in vacuum modes and the airloads are then expressed as an algebraic sum of the mode shapes, modal amplitudes, mass distribution, and frequency properties. The modal amplitudes are identified from the blade bending moments using the Strain Pattern Analysis Method. The application of the method is examined using simulated

flap bending moment data that have been calculated for measured airloads for a full-scale rotor in a wind tunnel. The estimated airloads are compared with the wind tunnel measurements. The effects of the number of measurements, the number of modes, and errors in the measurements and the blade properties are examined, and the method is shown to be robust. Author

**N87-29422*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**INVESTIGATION OF GENERIC HUB FAIRING AND PYLON SHAPES TO REDUCE HUB DRAG**
Robert H. Stroub, Larry A. Young, David R. Graham, and Alexander W. Louie (Sterling Software, Moffett field, Calif.) Sep. 1987 19 p Presented at the 13th European Rotorcraft Forum, Arles, France, 8-11 Sep. 1987
(NASA-TM-100008; A-87287; NAS 1.15:100008) Avail: NTIS HC A02/MF A01 CSCL 01A

Reported are investigations of fairing configurations pointed toward substantially reducing hub drag. Experimental investigations have shown the importance of hub-fairing camber, lower-surface curvature, and relative size of the drag. The significance of pylon and hub fairings in combination have also been shown. Model test data presented here documented these findings, and also showed the effect of gaps and hub-fairing inclination angle on drag. From a drag standpoint, the best hub fairing had a circular arc, upper-surface curvature, a flat bottom surface, and 8.75% camber. Author

**N87-29423*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**CONTRIBUTIONS OF NUMERICAL SIMULATION DATA BASES TO THE PHYSICS, MODELING AND MEASUREMENT OF TURBULENCE**
Parviz Moin and Philippe R. Spalart Sep. 1987 33 p
(NASA-TM-100022; A-87276; NAS 1.15:100022) Avail: NTIS HC A03/MF A01 CSCL 01A

The use of simulation data bases for the examination of turbulent flows is an effective research tool. Studies of the structure of turbulence have been hampered by the limited number of probes and the impossibility of measuring all desired quantities. Also, flow visualization is confined to the observation of passive markers with limited field of view and contamination caused by time-history effects. Computer flow fields are a new resource for turbulence research, providing all the instantaneous flow variables in three-dimensional space. Simulation data bases also provide much-needed information for phenomenological turbulence modeling. Three dimensional velocity and pressure fields from direct simulations can be used to compute all the terms in the transport equations for the Reynolds stresses and the dissipation rate. However, only a few, geometrically simple flows have been computed by direct numerical simulation, and the inventory of simulation does not fully address the current modeling needs in complex turbulent flows. The availability of three-dimensional flow fields also poses challenges in developing new techniques for their analysis, techniques based on experimental methods, some of which are used here for the analysis of direct-simulation data bases in studies of the mechanics of turbulent flows. Author

**N87-29424*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**ON THE INTERACTION OF SMALL AND LARGE EDDIES IN TWO DIMENSIONAL TURBULENT FLOWS Final Report**
C. Foias, O. Manley, and R. Temam (Paris-Sud Univ., Orsay, France) Sep. 1987 45 p
(Contract NAS1-18107)
(NASA-CR-178370; ICASE-87-60; NAS 1.26:178370) Avail: NTIS HC A03/MF A01 CSCL 01A

Some results concerning the interaction of small and large eddies to two dimensional turbulent flows are presented. It is shown that the amplitude of small structures decays exponentially to a small value, and from this is inferred a simplified interaction law of small and large eddies. Beside their intrinsic interest for the understanding of the physics of turbulence, these results lead to new numerical schemes to be studied in a separate work. Author

**N87-29425#** Vigyan Research Associates, Inc., Hampton, Va.
**LOW-SPEED INVESTIGATIONS OF APEX FENCE AND CAVITY FLAP CONCEPTS ON A 60 DEGREES DELTA CONFIGURATION Final Report, 15 Mar. 1985 - 15 Oct. 1986**
Dhanvada M. Rao, Keith D. Hoffler, and Charles T. Mills Mar. 1987 74 p
(Contract F33615-85-C-3008)
(AD-A183138; AFWAL-TR-86-3114) Avail: NTIS HC A04/MF A01 CSCL 20D

This report describes low-speed wind tunnel investigations of apex fence and cavity flap concepts applied to a 60-deg. uncambered delta wing/body configuration. The upper-surface apex fences, hinged near the leading edges, are deployed vertically at low to moderate angles of attack (appropriate to approach and landing) to force a powerful vortex pair which augments suction over the forward regions of the wing planform. The resulting nose-up moment is balanced by means of trailing edge flaps, resulting in increased trimmed lift as well as drag for improved short-field landing capability of the tailless delta. The cavity flap is a lower-surface hinged vortex flap whose deflection creates a frontal cavity underneath the leading edge. Above a certain angle of attack the flap vortex fills the mouth of the cavity, which helps the external flow to turn around the leading edge thus reducing the vortex lift at high angles of attack, and creates suction over the cavity frontal area which generates a side-force component. The potential of asymmetrically deployed cavity flaps for lateral/directional control at high angles of attack was of interest. These concepts were subjected to low-speed tunnel studies. GRA

**N87-29426#** Naval Weapons Center, China Lake, Calif.
**PARACHUTE RECOVERY SYSTEMS DESIGN MANUAL, CHAPTER 5 Partial Report, Jan. - May 1987**
Theo W. Knacke Jun. 1987 182 p
(AD-A183191; AD-E900716; NWC-TP-6575-CH-5-OFFPRINT)
Avail: NTIS HC A09/MF A01 CSCL 01C

This manual provides the recovery system engineer in Government and industry with tools to evaluate, select, design, test, manufacture, and operate parachute recovery systems. These systems range from simple, one-parachute assemblies to multiple-parachute systems, and may include equipment for impact attenuation, flotation, location, retrieval, and disposition. All system aspects are discussed, including the need for parachute recovery, the selection of the most suitable recovery system concept, a computerized approach to parachute performance, force and stress analysis, geometric gore design, component layout, material selection, system design, manufacturing, and in-service maintenance. GRA

**N87-29427#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
**NUMERICAL SIMULATION OF X24C-10D Final Report, Jun. 1984 - Jul. 1985**
Joseph J. Shang and Stephen J. Scherr Jun. 1987 59 p
(AD-A183287; AFWAL-TR-86-3072) Avail: NTIS HC A04/MF A01 CSCL 01A

The present effort represents a first attempt of numerical simulation of the flow field around a complete aircraft configuration utilizing the Reynolds average Navier-Stokes equations. The numerical solution generated for the experimental aircraft concept X24C-10D at a Mach number of 5.95 not only exhibited accurate prediction of detailed flow properties but also of the integrated aerodynamic coefficients. In addition, the present analysis demonstrated that a page structure of data collected in cyclic blocks is an efficient and viable means for processing the Navier-Stokes equations on the Cray XMP-22 computer with external memory device. Author (GRA)

**N87-29428#** Physical Research, Inc., Torrance, Calif.
**HIGH REYNOLDS NUMBER FLOWS AROUND SMOOTH AND ROUGH CYLINDERS. VOLUME 1. MEAN SURFACE PRESSURE DISTRIBUTION Final Report, 21 Aug. 1985 - 20 Aug. 1986**
Chiun Wang and W. C. Shih 2 Mar. 1987 309 p
(Contract N00014-85-C-0764)
(AD-A183531; PRI-PV-87-R001-Vol-1) Avail: NTIS HC A14/MF A01 CSCL 20D

Nonsteady phenomena associated with flows around smooth and rough cylinders at high Reynolds numbers (300,000 to 8 million) were investigated. Boundary-layer profiles were surveyed. Mean and fluctuating surface pressures were measured in both the circumferential and the spanwise directions. The mean surface pressure data are compiled and presented in the Volume 1 report using both graphical and tabular format. Mean sectional drag and lift coefficients were calculated. The drag coefficients, the base pressures, and the boundary-layer separation angles were also compared to data existing in the literature. GRA

**N87-29429*#** Vanderbilt Univ., Nashville, Tenn. Dept. of Mechanical and Materials Engineering.
**AERODYNAMICS OF 3-DIMENSIONAL BODIES IN TRANSITIONAL FLOW**
J. Leith Potter 11 Oct. 1987 14 p
(Grant NAG1-549)
(NASA-CR-181395; NAS 1.26:181395) Avail: NTIS HC A02/MF A01 CSCL 01A

Based on considerations of fluid dynamic simulation appropriate to hypersonic, viscous flow over blunt-nosed lifting bodies, a method was presented earlier for estimating drag coefficients in the transitional-flow regime. The extension of the same method to prediction of lift coefficients is presented. Correlation of available experimental data by a simulation parameter appropriate for this purpose is the basis for the procedure described. The ease of application of the method makes it useful for preliminary studies which involve a wide variety of three-dimensional vehicle configurations or a range of angles of attack of a given vehicle. Author

**N87-29430*#** Eloret Corp., Sunnyvale, Calif.
**EXPERIMENTAL INVESTIGATION OF HYPERSONIC AERODYNAMICS Semiannual Research Report, 1 Apr. - 30 Sep. 1987**
K. Heinemann and Peter F. Intrieri 14 Oct. 1987 11 p
(Contract NCC2-475)
(NASA-CR-181374; NAS 1.26:181374) Avail: NTIS HC A02/MF A01 CSCL 01A

An extensive series of ballistic range tests are currently being conducted at the Ames Research Center. These tests are intended to investigate the hypersonic aerodynamic characteristics of two basic configurations, which are: the blunt-cone Galileo probe which is scheduled to be launched in late 1989 and will enter the atmosphere of Jupiter in 1994, and a generic slender cone configuration to provide experimental aerodynamic data including good flow-field definition which computational aerodynamicists could use to validate their computer codes. Some of the results obtained thus far are presented and work for the near future is discussed. Author

**N87-29431*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**TRANSONIC ROTOR TIP DESIGN USING NUMERICAL OPTIMIZATION**
Michael E. Tauber and Ronald G. Langhi Oct. 1985 41 p
(NASA-TM-86771; Rept-85333; NAS 1.15:86771) Avail: NTIS HC A03/MF A01 CSCL 01A

The aerodynamic design procedure for a new blade tip suitable for operation at transonic speeds is illustrated. For the first time, 3 dimensional numerical optimization was applied to rotor tip design, using the recent derivative of the ROT22 code, program R22OPT. Program R22OPT utilized an efficient quasi-Newton optimization algorithm. Multiple design objectives were specified. The delocalization of the shock wave was to be eliminated in forward flight for an advance ratio of 0.41 and a tip Mach number of 0.92 at psi = 90 deg. Simultaneously, it was sought to reduce torque requirements while maintaining effective restoring pitching moments. Only the outer 10 percent of the blade span was modified; the blade area was not to be reduced by more than 3 percent. The goal was to combine the advantages of both sweptback and sweptforward blade tips. A planform that featured inboard sweepback was combined with a sweptforward tip and a taper ratio of 0.5. Initially, the ROT22 code was used to find by trial and error a planform geometry which met the design goals. This configuration had an inboard section with a leading edge sweep of 20 deg and a tip section swept forward at 25 deg; in addition, the airfoils were modified. Author

**N87-29432*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**AUTOMATED REDUCTION OF DATA FROM IMAGES AND HOLOGRAMS**
G. Lee, ed., James D. Trolinger, ed. (Spectron Development Labs., Inc., Costa Mesa, Calif.), and Y. H. Yu, ed. May 1987 614 p Workshop held at Moffett Field, Calif., 10-11 Jan. 1985
(NASA-CP-2477; A-87135; NAS 1.55:2477) Avail: NTIS HC A99/MF A01 CSCL 01A

Laser techniques are widely used for the diagnostics of aerodynamic flow and particle fields. The storage capability of holograms has made this technique an even more powerful. Over 60 researchers in the field of holography, particle sizing and image processing convened to discuss these topics. The research program of ten government laboratories, several universities, industry and foreign countries were presented. A number of papers on holographic interferometry with applications to fluid mechanics were given. Several papers on combustion and particle sizing, speckle velocimetry and speckle interferometry were given. A session on image processing and automated fringe data reduction techniques and the type of facilities for fringe reduction was held. For individual titles, see N87-29433 through N87-29460.

**N87-29433*#** Michigan Univ., Ann Arbor.
**INFORMATION RETRIEVAL FROM HOLOGRAPHIC INTERFEROGRAMS: FUNDAMENTALS AND PROBLEMS** c35
Charles M. Vest *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 1-20 Sponsored by the Army Research Office (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

Holographic interferograms can contain large amounts of information about flow and temperature fields. Their information content can be very high because they can be viewed from many different directions. This multidirectionality, and fringe localization add to the information contained in the fringe pattern if diffuse illumination is used. Additional information, and increased accuracy can be obtained through the use of dual reference wave holography to add reference fringes or to effect discrete phase shift or hetrodyne interferometry. Automated analysis of fringes is possible if interferograms are of simple structure and good quality. However, in practice a large number of practical problems can arise, so that a difficult image processing task results. Author

**N87-29434*#** Army Research and Technology Labs., Moffett Field, Calif.
**TRANSONIC ROTOR FLOW-MEASUREMENT TECHNIQUE USING HOLOGRAPHIC INTERFEROMETRY** c35
John K. Kittleson and Yung H. Yu *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 49-51 Previously announced in IAA as A86-17069 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

Holographic interferometry is used to record interferograms of the flow near a hovering transonic rotor blade. A pulsed ruby laser recorded 40 interferograms with a 2 ft dia. view field near the model rotor blade tip operating at a tip Mach number of 0.90. The experimental procedure is presented and example interferograms recorded in the rotor's tip path plane. In addition,

a method currently being pursued to obtain quantitative flow information using computer assisted tomography (CAT) with the holographic interferogram data, is outlined. Author

**N87-29435*#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
**HOLOGRAPHIC INTERFEROMETRY AT WRIGHT AERONAUTICAL LABORATORIES Abstract Only** **c35**
Mel Roquemore *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 67 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 01A

The optical diagnostics requirements and plans for the Aero Propulsion Lab. are described. This laboratory is performing work in combustion as related to aero propulsion systems. They would like to use holography and other types of optical instrumentation for combustion diagnostics and flow visualization. A movie of a laser light sheet flow visualization of a combustor in operation was shown. This movie showed extremely clear examples of vortical and unsteady flow, and it would be of interest to use image analysis to quantify such data. Author

**N87-29436*#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
**STATUS OF HOLOGRAPHIC INTERFEROMETRY AT WRIGHT PATTERSON AIR FORCE BASE Abstract Only** **c35**
George Seibert *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 69 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

At Wright Patterson AFB, holographic interferometry has been used for nearly 15 years in a variety of supersonic and hypersonic wind tunnels. Specifically, holographic interferometry was used to study boundary layers, shock boundary layer interaction, and general flow diagnostics. Although a considerable amount of quantitative work was done, the difficulty of reducing data severely restricted this. In the future, it is of interest to use holographic interferometry in conjunction with laser Doppler velocimetry to do more complete diagnostics. Also, there is an interest to do particle field diagnostics in the combustion research facility. Finally, there are efforts in nondestructive testing where automated fringe readout and analysis would be extremely helpful. Author

**N87-29437*#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.
**WELDING ARC AND PLASMA STUDIES USING REAL TIME, MULTIPASS HOLOGRAPHIC INTERFEROMETRY** **c35**
Vance Deason *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 71-76 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

Flow visualization of the plasma process in a welding arc is being studied with a multipass Argon ion interferometer. High speed movies at 10,000 frames per/sec are taken. The multipass interferometer and several interferograms of the plasma near the electrode of the welding are given. Digitization of the fringes is currently done by hand. Author

**N87-29438*#** Spectron Development Labs., Inc., Costa Mesa, Calif.
**HOLOGRAPHIC, PARTICLE IMAGING AND DATA REDUCTION AT SPECTRON DEVELOPMENT LABORATORES Abstract Only** **c35**
James D. Trolinger *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 77 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

Spectron has been deeply involved in the development and use of a wide variety of particle and flow diagnostic, electro optical instruments. Holography and imaging systems have played an important role in this work, but the extraction of data from images and holograms have always presented a limit to their use. Systems and techniques were devised to speed up and automate the extraction of data from holographic and conventional interferograms, particle images and holograms, and other types of optical flow visualization techniques. An IBM/AI based image analyzer was developed that is capable of automatically analyzing many useful image types including interferograms. A key feature of this system is the low total cost of the required hardware. In the particle field work, a commercial diffraction field analyzer was adopted to the image reconstructed from a hologram. This could expand the use of holography in particle diagnostics greatly. Author

**N87-29439*#** Michigan Univ., Ann Arbor.
**STATUS OF HOLOGRAPHIC INTERFEROMETRY AT UNIVERSITY OF MICHIGAN Abstract Only** **c35**
Charles Vest *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 91 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

Reflection holograms were taken of a jet of air injected traverse to a subsonic stream. The technique of reflection holograms allowed maximum viewing angle and minimum distance to the jet. Holographic interferometry is being used to measure the temperature distribution in a growing crystal. Computations of the temperatures are being made. A phase shift interferometer was used to study flows with very weak changes in refractive index, of the order of 1 shift. Tomographic techniques are being developed for strong refractive cases. Author

**N87-29440*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**FLOW VISUALIZATION OF ACOUSTIC LEVITATION EXPERIMENT** **c35**
Ed Baroth *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 93-99 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

Acoustic levitation experiments for space applications were performed. Holographic interferometry is being used to study the heat transfer rates on a heated rod enclosed in a 6 cu in chamber. Acoustic waves at levels up to 150 db increased the heating rates to the rod by factors of three to four. High speed real time holographic interferometry was used to measure the boundary layer on the heated rod. Data reduction and digitization of the interferograms are being implemented. Author

**N87-29441*#** Aerodyne Research, Inc., Billerica, Mass.
**TOWARD AUTOMATED ANALYSIS OF PARTICLE HOLOGRAMS** **c35**
H. J. Caulfield *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 101-110 Previously announced in IAA as A85-35204 (For primary document see N87-29432 24-02)
(ARI-RR-449) Avail: NTIS HC A99/MF A01 CSCL 14E

A preliminary study of approaches for extracting and analyzing data from particle holograms is discussed. It concludes that: (1) for thin spherical particles, out-of-focus methods are optimum; (2) for thin nonspherical particles, out-of-focus methods are useful but must be supplemented by in-focus methods; (3) a complex method of projection and back projection can remove out-of-focus data for deep particles. Author

**N87-29442*#** National Bureau of Standards, Washington, D.C.
**TEMPERATURE AND CONCENTRATION MEASUREMENTS IN COMBUSTION Abstract Only** **c35**
Takashi Kashiwagi *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 115 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

A high speed two wavelength holographic interferometer is being used to simultaneously measure temperature and concentration distributions for ignition and flame spread. Lines from a cw CO2 laser were used and the holograms recorded on a movie at 500 frames per/sec, individual frames were digitized with

a microdensitometer. The detection on the fringe center was a major problem. Author

**N87-29443*#** Gunma Univ., Maebashi (Japan). Dept. of Mechanical Engineering.
**PARTICLE DATA REDUCTION IN JAPAN c72**
Mitsushige Nakayama *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 117-133 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 20H

The characterization of atomized particles generated by various atomizer and the mechanics of their evaporation and combustion processes were studied. The need existed for visualizing the internal structure of flames including evaporation and combustion processes as well as for a better way of understanding spray particle generation mechanisms and internal structures. A particle sizer based on Fraunhofer diffraction for detecting particle size and in-line Fraunhofer holograms for observation of local spray particles were used. A novel visualizing technique based on Computer Technology was developed and is discussed. E.R.

**N87-29444*#** Naval Postgraduate School, Monterey, Calif.
**COMBUSTION/PARTICLE SIZING EXPERIMENTS AT THE NAVAL POSTGRADUATE SCHOOL COMBUSTION RESEARCH LABORATORY c25**
John Powers and David Netzer *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 135-136 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 07D

Particle behavior in combustion processes is an active research area at NPS. Currently, four research efforts are being conducted: (1) There is a long standing need to better understand the soot production and combustion processes in gas turbine combustors, both from a concern for improved engine life and to minimize exhaust particulates. Soot emissions are strongly effected by fuel composition and additives; (2) A more recent need for particle sizing/behavior measurements is in the combustor of a solid fuel ramjet which uses a metallized fuel. High speed motion pictures are being used to study rather large burning particles; (3) In solid propellant rocket motors, metals are used to improve specific impulse and/or to provide damping for combustion pressure oscillations. Particle sizing experiments are being conducted using diode arrays to measure the light intensity as a function of scattering angle; (4) Once a good quality hologram is attained, a need exists for obtaining the particle distributions from hologram in a short period of time. A Quantimet 720 Image Analyzer is being used to reconstruct images. Author

**N87-29445*#** Army Research and Technology Labs., Moffett Field, Calif.
**RECONSTRUCTION OF A THREE-DIMENSIONAL, TRANSONIC ROTOR FLOW FIELD FROM HOLOGRAPHIC INTERFEROGRAM DATA**
John K. Kittleson and Yung H. Yu *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 149-170 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 01A

Holographic interferometry and computerized aided tomography (CAT) are used to determine the transonic velocity field of a model rotor blade in hover. A pulsed ruby laser recorded 40 interferograms with a 2 ft dia view field near the model rotor blade tip operating at a tip Mach number of 0.90. After digitizing the interferograms and extracting the fringe order functions, the data are transferred to a CAT code. The CAT code then calculates the perturbation velocity in several planes above the blade surface. The values from the holography-CAT method compare favorably with previously obtained numerical computations in most locations near the blade tip. The results demonstrate the technique's potential for three dimensional transonic rotor flow studies. Author

**N87-29446*#** Stanford Univ., Calif. Dept. of Aeronautics/Astronautics and Electrical Engineering.
**HIGH SPEED OPTICAL TOMOGRAPHY FOR FLOW VISUALIZATION c35**
Ray Snyder and Lambertus Hesselink *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 171-191 Previously announced in IAA as A86-19160 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

A novel optical architecture (based on holographic optical elements) for making high speed tomographic measurements is presented. The system is designed for making density or species concentration measurements in a nonsteady fluid or combustion flow. Performance evaluations of the optical system are discussed, and a test phase object was successfully reconstructed using this optical arrangement. Author

**N87-29447*#** Aerometrics, Inc., Mountain View, Calif.
**OPTICAL INTERFEROMETRY IN FLUID DYNAMICS RESEARCH c35**
W. D. Bachalo and M. J. Houser *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 193-247 Previously announced in IAA as A85-35203 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

Optical interferometry techniques were applied to the investigation of transonic airfoil flow fields in large wind tunnels. Holographic interferometry techniques were used to study 2 dimensional symmetric NACA 64A010 and Douglas Aircraft Co. DSMA671 supercritical airfoil performance in the NASA Ames 2 x 2 ft transonic wind tunnel. Quantitative data obtained from the interferograms were compared to the surface pressure data. The agreement obtained verified the accuracy of the flow visualization and demonstrated the potential for acquiring quantitative scalar results. Measurements of the inviscid flow speed and the boundary layer and wake velocity profiles were extracted from the interferograms and compared to laser Doppler velocimeter measurements. These results were also in good agreement. A method for acquiring real time interferometric data in large scale facilities was developed. This method, based on the point diffraction interferometer, was successfully tested in the 2 x 2 ft transonic wind tunnel. The holographic and real time interferometry methods were applied to the investigations of circulation control airfoils utilizing the Coanda effect. These results reveals the details of the jet interacting with the trailing edge boundary layer and the other parameters affecting the lift augmentation. Author

**N87-29448*#** Cambridge Univ. (England).
**TRANSONIC FLOW VISUALIZATION USING HOLOGRAPHIC INTERFEROMETRY c35**
Peter J. Bryanston-Cross *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 261-293 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

An account is made of some of the applications of holographic interferometry to the visualization of transonic flows. In the case of the compressor shock visualization, the method is used regularly and has moved from being a research department invention to a design test tool. With the implementation of automatic processing and simple digitization systems, holographic vibrational analysis has also moved into routine nondestructive testing. The code verification interferograms were instructive, but the main turbomachinery interest is now in 3 dimensional flows. A major data interpretation effort will be required to compute tomographically the 3 dimensional flow around the leading or the trailing edges of a rotating blade row. The bolt on approach shows the potential application to current unsteady flows of interest. In particular that of the rotor passing and vortex interaction effects is experienced by the new generation of unducted fans. The turbocharger tests presents a new area for the application of holography. Author

**N87-29449*#** Florida State Univ., Tallahassee. Fluid Mechanics Research Lab.

**THE DEVELOPMENT OF LASER SPECKLE OR PARTICLE IMAGE DISPLACEMENT VELOCIMETRY. PART 1: THE ROLE OF PHOTOGRAPHIC PARAMETERS** **c35**

L. M. M. Lourenco and A. Krothapalli *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 295-341 (For primary document see N87-29432 24-02)

(FMRL-TR-1-Pt-1) Avail: NTIS HC A99/MF A01 CSCL 14E

One of the difficult problems in experimental fluid dynamics remains the determination of the vorticity field in fluid flows. Recently, a novel velocity measurement technique, commonly known as Laser Speckle or Particle Image Displacement Velocimetry became available. This technique permits the simultaneous visualization of the 2 dimensional streamline pattern in unsteady flows and the quantification of the velocity field. The main advantage of this new technique is that the whole 2 dimensional velocity field can be recorded with great accuracy and spatial resolution, from which the instantaneous vorticity field can be easily obtained. A apparatus used for taking particle displacement images is described. Local coherent illumination by the probe laser beam yielded Young's fringes of good quality at almost every location of the flow field. These fringes were analyzed and the velocity and vorticity fields were derived. Several conclusions drawn are discussed. E.R.

**N87-29450*#** Dayton Univ., Ohio. Dept. of Mechanical Engineering.

**COMPUTATIONAL INTERFEROMETRIC DESCRIPTION OF NESTED FLOW FIELDS** **c35**

A. George Havener and L. A. Obergefell (Systems Research Labs., Inc., Dayton, Ohio.) *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 343-368 (For primary document see N87-29432 24-02)

Avail: NTIS HC A99/MF A01 CSCL 14E

Computer graphics and theoretical descriptions of density are used to obtain computer generated flow visualizations called computational interferograms. Computational interferograms are pictorially analogous to optical interferograms, and examples showing the fringe pattern for the flow about a sharp tip cone in a supersonic air stream are presented. To ascertain the effect of unsteady behavior, local density disturbances are added to the steady state flow field. This introduces irregularities to the computational interferogram like those seen in the optical interferograms. These theoretical disturbances can be varied in geometry, density description, translated with time, and strengthened or dissipated. The accuracy of computational interferometry relies on the accuracy of the theoretical density descriptions and therefore, it provides a way of verifying existing models of flow fields, especially those containing unsteady or turbulent behavior. In addition to being a unique method of flow visualization, computational interferometry can be used to develop and modify theories or numerical solutions to both simple and complex flow fields. The presented research is a general description of this process. Author

**N87-29451*#** Army Research and Technology Labs., Moffett Field, Calif. Aeromechanics Lab.

**APPLICATION OF DIGITAL INTERFEROGRAM EVALUATION TECHNIQUES TO THE MEASUREMENT OF 3-D FLOW FIELDS** **c35**

Friedhelm Becker and Yung Yu, H. *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 369-431 Previously announced in IAA as A85-20852 (For primary document see N87-29432 24-02)

Avail: NTIS HC A99/MF A01 CSCL 14E

A system for digitally evaluating interferograms, based on an image processing system connected to a host computer, was implemented. The system supports one- and two-dimensional interferogram evaluations. Interferograms are digitized, enhanced, and then segmented. The fringe coordinates are extracted, and the fringes are represented as polygonal data structures. Fringe numbering and fringe interpolation modules are implemented. The system supports editing and interactive features, as well as graphic visualization. An application of the system to the evaluation of double exposure interferograms from the transonic flow field around a helicopter blade and the reconstruction of the three dimensional flow field is given. Author

**N87-29452*#** Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).

**THE FRINGE READING FACILITY AT THE MAX-PLANCK-INSTITUT FUER STROEMUNGSFORSCHUNG** **c35**

F. Becker, G. E. A. Meier, H. Wegner, R. Timm, and R. Wenskus *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 433-436 (For primary document see N87-29432 24-02)

Avail: NTIS HC A99/MF A01 CSCL 14E

A Mach-Zehnder interferometer is used for optical flow measurements in a transonic wind tunnel. Holographic interferograms are reconstructed by illumination with a He-Ne-laser and viewed by a video camera through wide angle optics. This setup was used for investigating industrial double exposure holograms of truck tires in order to develop methods of automatic recognition of certain manufacturing faults. Automatic input is achieved by a transient recorder digitizing the output of a TV camera and transferring the digitized data to a PDP11-34. Interest centered around sequences of interferograms showing the interaction of vortices with a profile and subsequent emission of sound generated by this process. The objective is the extraction of quantitative data which relates to the emission of noise. Author

**N87-29453*#** Spectron Development Labs., Inc., Costa Mesa, Calif.

**A NEW ART CODE FOR TOMOGRAPHIC INTERFEROMETRY** **c35**

H. Tan and D. Modarress *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 437-459 Previously announced in IAA as A85-35201 (For primary document see N87-29432 24-02)

Avail: NTIS HC A99/MF A01 CSCL 14E

A new algebraic reconstruction technique (ART) code based on the iterative refinement method of least squares solution for tomographic reconstruction is presented. Accuracy and the convergence of the technique is evaluated through the application of numerically generated interferometric data. It was found that, in general, the accuracy of the results was superior to other reported techniques. The iterative method unconditionally converged to a solution for which the residual was minimum. The effects of increased data were studied. The inversion error was found to be a function of the input data error only. The convergence rate, on the other hand, was affected by all three parameters. Finally, the technique was applied to experimental data, and the results are reported. Author

**N87-29454*#** Spectron Development Labs., Inc., Costa Mesa, Calif.

**KC-135 AERO-OPTICAL TURBULENT BOUNDARY LAYER/SHEAR LAYER EXPERIMENT REVISITED** **c34**

J. Craig and C. Allen (Air Force Weapons Lab., Kirtland AFB, N. Mex.) *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 461-503 (For primary document see N87-29432 24-02)

Avail: NTIS HC A99/MF A01 CSCL 20D

The aero-optical effects associated with propagating a laser beam through both an aircraft turbulent boundary layer and artificially generated shear layers are examined. The data present comparisons from observed optical performance with those inferred from aerodynamic measurements of unsteady density and correlation lengths within the same random flow fields. Using optical instrumentation with tens of microsecond temporal resolution through a finite aperture, optical performance degradation was determined and contrasted with the infinite aperture time averaged

aerodynamic measurement. In addition, the optical data were artificially clipped to compare to theoretical scaling calculations. Optical instrumentation consisted of a custom Q switched Nd:Yag double pulsed laser, and a holographic camera which recorded the random flow field in a double pass, double pulse mode. Aerodynamic parameters were measured using hot film anemometer probes and a five hole pressure probe. Each technique is described with its associated theoretical basis for comparison. The effects of finite aperture and spatial and temporal frequencies of the random flow are considered. Author

**N87-29455*#** Lockheed-Georgia Co., Marietta.
**AUTOMATED REDUCTION OF INSTANTANEOUS FLOW FIELD IMAGES** **c34**
G. A. Reynolds, M. Short, and M. C. Whiffen *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 505-524 Previously announced in IAA as A85-35206 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 20D

An automated data reduction system for the analysis of interference fringe patterns obtained using the particle image velocimetry technique is described. This system is based on digital image processing techniques that have provided the flexibility and speed needed to obtain more complete automation of the data reduction process. As approached here, this process includes scanning/searching for data on the photographic record, recognition of fringe patterns of sufficient quality, and, finally, analysis of these fringes to determine a local measure of the velocity magnitude and direction. The fringe analysis as well as the fringe image recognition are based on full frame autocorrelation techniques using parallel processing capabilities. Author

**N87-29456*#** Gunma Univ., Maebashi (Japan). Dept. of Mechanical Engineering.
**IMAGE ANALYSIS OF PARTICLE FIELD BY MEANS OF COMPUTED TOMOGRAPHY** **c34**
Mitsushige Nakayama *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 525-539 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 20D

In order to visualize and investigate spray structures, computed tomography technique is applied to analyze droplet information. From the transmitted light intensity through the spray and/or the data of particle size distribution obtained from a Fraunhofer diffraction principle, the quantitative volume of spray droplet or local particle size was calculated and the reconstruction of spray structures was made. The background of computed tomography is described along with some experimental results of the structure of intermittent spray such as diesel spray. Author

**N87-29457*#** Spectron Development Labs., Inc., Costa Mesa, Calif.
**PARTICLE FIELD HOLOGRAPHY DATA REDUCTION BY FOURIER TRANSFORM ANALYSIS** **c35**
Cecil F. Hess and James D. Trolinger *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 541-564 Previously announced in IAA as A86-32304 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

The size distribution of a particle field hologram is obtained with a Fourier transformation of the Fraunhofer diffraction pattern of the reconstructed hologram. Off-axis absorption holograms of particle fields with known characteristics were obtained and analyzed with a commercially available instrument. The mean particle size of the reconstructed hologram was measured with an error of + or - 5 percent, while the distribution broadening was estimated within + or - 15 percent. Small sections of a pulsed laser hologram of a synthetic fuel spray were analyzed with this method thus yielding a spatially resolved size distribution. The method yields fast and accurate automated analysis of particle field holograms. Author

**N87-29458*#** Spectron Development Labs., Inc., Costa Mesa, Calif.
**PARTICLE AND FLOW FIELD HOLOGRAPHY: A CRITICAL SURVEY** **c35**
James D. Trolinger *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 565-587 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

A brief background is provided for the fields of particle and flow visualization holography. A summary of methods currently in use is given, followed by a discussion of more recent and unique applications. The problem of data reduction is discussed. A state of the art summary is then provided with a prognosis of the future of the field. Particle and flow visualization holography are characterized as powerful tools currently in wide use and with significant untapped potential. Author

**N87-29459*#** Naval Postgraduate School, Monterey, Calif.
**PARTICLE SIZING IN ROCKET MOTOR STUDIES UTILIZING HOLOGRAM IMAGE PROCESSING** **c20**
David Netzer and John Powers *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 589-606 Sponsored by AFRPL, Edwards AFB, Calif. (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 21H

A technique of obtaining particle size information from holograms of combustion products is described. The holograms are obtained with a pulsed ruby laser through windows in a combustion chamber. The reconstruction is done with a krypton laser with the real image being viewed through a microscope. The particle size information is measured with a Quantimet 720 image processing system which can discriminate various features and perform measurements of the portions of interest in the image. Various problems that arise in the technique are discussed, especially those that are a consequence of the speckle due to the diffuse illumination used in the recording process. Author

**N87-29460*#** General Motors Research Labs., Warren, Mich. Instrumentation Dept.
**IMAGE PROCESSING SYSTEM TO ANALYZE DROPLET DISTRIBUTIONS IN SPRAYS** **c34**
Gary P. Bertollini, Larry M. Oberdier, and Yong H. Lee *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 607-640 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 20D

An image processing system was developed which automatically analyzes the size distributions in fuel spray video images. Images are generated by using pulsed laser light to freeze droplet motion in the spray sample volume under study. This coherent illumination source produces images which contain droplet diffraction patterns representing the droplets degree of focus. The analysis is performed by extracting feature data describing droplet diffraction patterns in the images. This allows the system to select droplets from image anomalies and measure only those droplets considered in focus. Unique features of the system are the totally automated analysis and droplet feature measurement from the grayscale image. The feature extraction and image restoration algorithms used in the system are described. Preliminary performance data is also given for two experiments. One experiment gives a comparison between a synthesized distribution measured manually and automatically. The second experiment compares a real spray distribution measured using current methods against the automatic system. Author

**N87-29461*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**APPLICATION OF A PANEL METHOD TO WAKE-VORTEX/WING INTERACTION AND COMPARISON WITH EXPERIMENTAL DATA**
Brian E. Smith and James C. Ross Sep. 1987 74 p (NASA-TM-88337; A-86330; NAS 1.15:88337) Avail: NTIS HC A04/MF A01 CSCL 01A

The ability of the Vortex Separation AEROdynamics (VSAERO) program to calculate aerodynamic loads on wings due to interaction with free vortices was studied. The loads were calculated for various positions of a downstream following wing relative to an upstream vortex-generating wing. Calculated vortex-induced span loads, rolling-moment coefficients, and lift coefficients on the following wing were compared with experimental results of McMillan et al. and El-Ramly et al. Comparisons of calculated and experimental vortex tangential velocities were also made. Author

**N87-29462*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A TWIN-ENGINE GENERAL AVIATION CONFIGURATION WITH AFT-FUSELAGE-MOUNTED PUSHER PROPELLERS**
Dana Morris Dunham, Garl L. Gentry, Jr., Gregory S. Manuel, Zachary T. Applin, and P. Frank Quinto Oct. 1987 116 p
(NASA-TP-2763; L-16331; NAS 1.60:2763) Avail: NTIS HC A06/MF A01 CSCL 01A

An investigation was conducted to determine the aerodynamic characteristics of an advanced turboprop aircraft model with aft-pylon-mounted pusher propellers. Tests were conducted through an angle-of-attack range of -8 to 28 degrees, and an angle-of-sideslip range of -20 to 20 degrees at free-stream conditions corresponding to Reynolds numbers of 0.55 to 2.14 x 10 to the 6th power based on mean aerodynamic chord. Test results show that for the unpowered configurations the maximum lift coefficients for the cruise, takeoff, and landing configurations are 1.45, 1.90, and 2.10, respectively. Nacelle installation results in a drag coefficient increase of 0.01. Increasing propeller thrust results in a significant increase in lift for angles of attack above stall and improves the longitudinal stability. The cruise configuration remains longitudinally stable to an angle of attack 5 degrees beyond the stall angle, the takeoff configuration is stable 4 degrees beyond stall angle, and the landing configuration is stable 3 degrees beyond stall angle. The predominant effect of symmetric thrust on the lateral-directional aerodynamic characteristics is in the post-stall region, where additional rudder control is available with power on. Author

**N87-29463** Cincinnati Univ., Ohio.
**DYNAMICS OF PARTICULATE-FLOW THROUGH RADIAL FLOW COMPRESSOR AND ANNULAR COMBUSTOR Ph.D. Thesis**
Salah Hassan Elfeki 1987 147 p
Avail: Univ. Microfilms Order No. DA8712709

A theoretical study of the particulate flows through a radial flow compressor with two different size splitters and an annular combustion chamber is presented. Three elements of the radial flow compressor are investigated, namely, the inlet, the impeller with the two splitters, and the vaneless diffuser. The three-dimensional flow field analysis for the radial flow compressor is presented with the corresponding solid particle trajectories through the compressor. The well-known theory describing the particle motion in a gas flow media is applied with accurate representation of the particle trajectories. The computation of the particle trajectories yields the particle impact locations with the compressor studies. The corresponding erosion patterns for each surface are calculated by using semi-empirical equations and experimental correlations. Particulate flows through the annular combustor was investigated. From the trajectory calculations, the locations of particle collisions with the outer and inner wall surfaces of the combustor are obtained and the particle distribution patterns at the combustor exit are determined. Dissert. Abstr.

**N87-29464** Arizona State Univ., Tempe.
**SUPERSONIC FLOW OVER ELASTIC BODIES IN OSCILLATION Ph.D. Thesis**
Pablo Nunez Garcia-Fogeda 1987 167 p
Avail: Univ. Microfilms Order No. DA8713657

Supersonic flow over flexible bodies of arbitrary cross section performing bending oscillations was investigated. For bodies of revolution three different systems, namely the wind-fixed, the body-fixed, and the pseudowind-fixed, are first investigated. It is shown that, when the wind-fixed system is used in a straightforward manner, a spurious singularity at the body apex appears. Further investigation of this singularity shows that it also appears in the other two coordinate systems when the linearized equation is solved. Also, it is shown that when the problem is properly formulated in a conical coordinate system the pressure coefficient remains regular at the body apex. The formulation is a generalization of the harmonic gradient method for oscillating wings. The influence of the mean flow nonlinearity on the unsteady pressure and forces was investigated for bodies of revolution according to Van Dyke's nonlinear iterative scheme. In all computed cases, improvements are found for the present nonlinear results over the linear ones. Flutter and divergence boundaries and aerodynamic damping coefficients for various configurations including that of a Saturn SA-1 launch vehicle in free-free bending modes of oscillation are presented. Overall close trends are established with measured data throughout the supersonic Mach number range. A spline panel method is introduced to generalize the present method to include the effect of body asymmetry.
Dissert. Abstr.

**N87-29465** George Washington Univ., Washington, D.C.
**FULL-POTENTIAL MODELING OF BLADE-VORTEX INTERACTIONS Ph.D. Thesis**
Henry Edward Jones 1987 193 p
Avail: Univ. Microfilms Order No. DA8708054

The primary goal was to investigate the effectiveness of the various methods of modeling a blade-vortex interaction (BVI). The problem was studied within the context of a 2-dimensional model problem, which represents one of the limiting types of BVIs. The model problem restricts the interaction to that of an infinite wing with an infinite line vortex moving parallel to its leading edge. A full-potential algorithm specifically tailored to solve the BVI was developed to solve this problem. The algorithm makes use of the unsteady mass conservation and Bernoulli equations to form a full-potential model of the flow field. The basic algorithm was modified to include the effect of a vortex passing near the airfoil. Four different methods of modeling the vortex were used: the angle-of-attack, the lifting-surface, the branch-cut, and the split-potential. A side by side comparison of the four models was conducted. These comparisons include: comparing generated velocity fields, a subcritical interaction, and a critical interaction. The split-potential model was used to make a survey of some of the more critical parameters which effect BVI. For the vortex parameters, the freestream Mach number was chosen to be just subcritical in order to study the effect of the vortex on the formulation of critical flow on the airfoil. Dissert. Abstr.

**N87-29466** California Univ., Los Angeles.
**AN EXPERIMENTAL INVESTIGATION OF WING-TIP TURBULENCE AND SOUND RADIATED FROM THE TIP REGION OF A BLUNT-TIPPED AIRFOIL Ph.D. Thesis**
Sally Anne McInerny 1987 311 p
Avail: Univ. Microfilms Order No. DA8713713

The characteristics of turbulence generated in the tip region of a blunt-tipped airfoil were studied using surface pressure measurements and limited hot-wire, velocity measurements. Tests were performed in the NASA Ames 7 x 10 foot wind tunnel at flow speeds of 75, 55, and 35 m/s (Reynolds numbers based on wing chord were 1.9, 3.0, and 4.1 x 10 to the 6th power) and angles of attack of 16, 12, and 6 degrees. The maximum, rms, pressure fluctuations measured in the tip region were on the order of the induced drag, or roughly proportional to the angle of attack squared. Dimensionless, pressure spectra measured at a fixed location and angle of attack collapsed well on the variables, t (the wing thickness) and U sub 0 (the freestream velocity). Upper surface pressure fluctuations were poorly correlated with those on the blunt tip. Fluctuations on the high pressure side of the wing were strongly correlated with, but 10 to 20 dB less intense than, those on the flat tip. A model was proposed that may explain the complex patterns of the measured surface pressure spectra and surface pressure cross-correlations. Two distinct sources of

blunt tip noise were found at an angle of attack of 16 degrees.
Dissert. Abstr.

**N87-29467** Notre Dame Univ., Ind.
**THE STRUCTURE OF LEADING EDGE VORTEX FLOWS INCLUDING VORTEX BREAKDOWN Ph.D. Thesis**
Francis Michael Payne 1987 351 p
Avail: Univ. Microfilms Order No. DA8712952

The structure of leading edge vortex flows on thin sharp edged delta wings was investigated at low Reynolds numbers. Flow visualization techniques were used to study the topology of the vortex and the phenomenon of vortex breakdown. Seven hole probe wake surveys and laser Doppler anemometer measurements were obtained and compared. Smoke flow visualization revealed the presence of small Kelvin-Helmholtz type vortical structures in the shear layer of a leading edge vortex. These shear layer vortices follow a helical path and grow in the streamwise direction as they wind into the vortex core where the individual shear layers merge. The phenomenon of vortex breakdown was studied using high speed cinema photography. The bubble and spiral type of breakdown were observed and appear to represent the extremes in a continuum of breakdown forms. Good agreement was obtained between the pressure probe and laser anemometer measurements. The influence of the probe on the vortex at critical conditions was found to depend on the size of the probe, the wing sweep, and the location of the breakdown relative to the wing.
Dissert. Abstr.

# 03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

**N87-29468#** General Accounting Office, Washington, D. C. Resources, Community and Economic Development Div.
**AVIATION SAFETY: PROCEDURES FOR REGISTERING AND CERTIFYING AIR CARRIERS**
May 1987 36 p
(PB87-193249; GAO/RCED-87-115FS; B-226786) Avail: NTIS HC A03/MF A01 CSCL 01C

The fact sheet describes the procedures two Dept. of Transportation (DOT) organizations, the Office of the Secretary of Transportation (OST) and the Federal Aviation Administration (FAA), use to register and certify air carriers of the type chartered by the Department of Defense (DOD). To document the procedures OST and FAA use to determine whether an air carrier should be granted these documents, officials were interviewed at OST and FAA headquarters and at FAA's flight standards district office in Seattle, Wash. At these locations, applicable FARS and various DOT, OST, and FAA records were reviewed. Although the registration and certification processes were documented, how well they were actually being carried out was not evaluated nor was how well OST monitors registration and certifications once they were granted. The report on the FAA's air carrier inspection program addresses how well FAA's inspection program monitors air carriers after they receive FAA operating certificates. GRA

**N87-29469*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**JET TRANSPORT FLIGHT OPERATIONS USING COCKPIT DISPLAY OF TRAFFIC INFORMATION DURING INSTRUMENT METEOROLOGICAL CONDITIONS: SIMULATION EVALUATION**
David H. Williams and Douglas C. Wells May 1986 50 p
(NASA-TP-2567; L-16091; NAS 1.60:2567) Avail: NTIS HC A03/MF A01 CSCL 01C

A simulation study was undertaken to evaluate flight operations using cockpit display of traffic information (CDTI) in a conventional jet transport aircraft. Eight two-person airline flight crews participated as test subjects flying simulated terminal area approach and departure operations under instrument meteorological conditions (IMC). A fixed-base cockpit simulator configured with a full complement of conventional electromechanical instrumentation to permit full workload operations was utilized. Traffic information was displayed on a color cathode-ray tube (CRT) mounted above the throttle quadrant in the typical weather radar location. A transparent touchpanel overlay was utilized for pilot interface with the display. Air traffic control (ATC) simulation included an experienced controller and full partyline radio environment for evaluation of pilot-controlled self-separation and traffic situation monitoring tasks. Results of the study revealed the CDTI to be well received by the test subjects as a useful system which could be incorporated into an existing jet transport cockpit. Crew coordination and consistent operating procedures were identified as important considerations in operational implementation of traffic displays. Cockpit workload was increased with active CDTI tasks. However, all test subjects rated the increase to be acceptable.
Author

**N87-29470*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**NEW METHODS AND MATERIALS FOR MOLDING AND CASTING ICE FORMATIONS**
Andrew L. Reehorst and G. Paul Richter Sep. 1987 16 p
(NASA-TM-100126; E-3673; NAS 1.15:100126) Avail: NTIS HC A02/MF A01 CSCL 01C

This study was designed to find improved materials and techniques for molding and casting natural or simulated ice shapes that could replace the wax and plaster method. By utilizing modern molding and casting materials and techniques, a new methodology was developed that provides excellent reproduction, low-temperature capability, and reasonable turnaround time. The resulting casts are accurate and tough.
Author

**N87-29471*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**ANALYSIS OF CONVAIR 990 REJECTED-TAKEOFF ACCIDENT WITH EMPHASIS ON DECISION MAKING, TRAINING AND PROCEDURES**
Byron E. Batthauer 1987 23 p Presented at the 40th International Air Safety Seminar, Tokyo, Japan, 26-29 Oct. 1987; sponsored by the Flight Safety Foundation, Inc.
(NASA-TM-100189; E-3771; NAS 1.15:100189) Avail: NTIS HC A02/MF A01 CSCL 01C

This paper analyzes a NASA Convair 990 (CV-990) accident with emphasis on rejected-takeoff (RTO) decision making, training, procedures, and accident statistics. The NASA Aircraft Accident Investigation Board was somewhat perplexed that an aircraft could be destroyed as a result of blown tires during the takeoff roll. To provide a better understanding of tire failure RTO's, The Board obtained accident reports, Federal Aviation Administration (FAA) studies, and other pertinent information related to the elements of this accident. This material enhanced the analysis process and convinced the Accident Board that high-speed RTO's in transport aircraft should be given more emphasis during pilot training. Pilots should be made aware of various RTO situations and statistics with emphasis on failed-tire RTO's. This background information could enhance the split-second decision-making process that is required prior to initiating an RTO.
Author

**N87-29472#** Air Force Occupational and Environmental Health Lab., Brooks AFB, Tex.
**COMBUSTION BY-PRODUCTS ON F-4 DROGUE PARACHUTES Final Report**
Bruce J. Poitrast, William C. Keller, and Robert G. Elves Jun. 1987 8 p
(AD-A182929; USAFOEHL-87-073C00253FOC) Avail: NTIS HC A02/MF A01 CSCL 01C

Concerns of F-4 drogue parachute packers concerning cracking and peeling dry skin led to analysis of the parachutes for polynuclear aromatic hydrocarbons (PAH). F-4 drogue parachutes with varying numbers of deployments were analyzed for PAH.

Results show a linear increase of PAH concentration with increasing deployments. Protective measures are suggested. GRA

**N87-29473#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
**LOW ALTITUDE LIGHTNING ATTACHMENT TO AN AIRCRAFT Interim Report, Oct. 1983 - Feb. 1985**
Pedro L. Rustan, Jr., Brian P. Kuhlman, Harold D. Burket, Jean S. Reazer, and Arturo Serrano May 1987 183 p
(AD-A183290; AFWAL-TR-86-3009) Avail: NTIS HC A09/MF A01 CSCL 04A

A CV-580 aircraft was instrumented with external displacement current density sensors, surface current density sensors, current shunts, and static electric field mill sensors and was flown in the neighborhood of active thunderstorms in central Florida during Summer 1984. Electromagnetic data were collected for 21 direct lighting strikes to the aircraft at altitudes between 2,000 and 18,000 ft. The data consisted of DC to 2 MHz analog records and 10.24 microsecond windows of digital samples taken at five nanosecond intervals. The data show the physical mechanism of lightning attachment to the aircraft. GRA

# 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

**N87-29474#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.
**ADVANCES IN GUIDANCE AND CONTROL SYSTEMS AND TECHNOLOGY**
Jul. 1987 146 p Symposium held in London, England, 7-10 Oct. 1986 Original contains color illustrations
(AGARD-CP-411; ISBN-92-835-0421-6) Copyright Avail: NTIS HC A07/MF A01

Papers were presented under the following headings: target and terrain sensors; aircraft state sensors; force and moment generators; guidance and control algorithms; and integrated systems. For individual titles, see N87-29475 through N87-29484.

**N87-29475#** Eltro G.m.b.H., Heidelberg (West Germany).
**EYE SAFE RAMAN LASER RANGE FINDER FOR GROUND AND AIRBORNE APPLICATION c36**
J. Ruger *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 9 p (For primary document see N87-29474 24-04)
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The need for an eye safe laser for military fire control systems, especially in the function as a range finder is described. The performance achieved with a Raman shifted Neodymium-YAG laser with a resulting wavelength of 1.54 microns is given in detail and compared to that of a 1.064 and 10.6 micron laser range finder under various atmospheric conditions. The use of the Raman range finder in prototype equipment contracted by the German MOD is described showing the advantages of eye safety and superior ranging performance as compared to the Neodymium-YAG laser range finder. Author

**N87-29476#** British Aerospace Public Ltd. Co., Bracknell (England). Electronic Systems and Equipment Div.
**THE BAe (BRACKNELL) AUTOMATIC DETECTION, TRACKING AND CLASSIFICATION SYSTEM c74**
C. J. Samwell and G. A. Cain *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 10 p (For primary document see N87-29474 24-04)
Copyright Avail: NTIS HC A07/MF A01

BAe Bracknell has designed and built real-time electro-optical digital tracking systems for 8 years. Tracking systems were purchased by the MOD and evaluated on MOD missile and target tracking trials. The BAe detection and tracking system uses images from infrared and TV sensors, mounted on a 2-axis platform, to detect and determine the angular position of an object with respect to the sensor boresight (boresight errors). These boresight errors are used to control the position of the platform such that the sensor tracks the object. The first and second generation centroid and correlation tracking systems have undergone several revisions. A third-generation system is described which provides the following facilities: image enhancement and segmentation, automatic detection of multiple objects, tracking of multiple objects, automatic acquisition of detected objects, automatic decoy/obscuration avoidance, and classification of objects. Author

**N87-29477#** Army Avionics Research and Development Activity, Fort Monmouth, N. J.
**VELOCITY ACCURACY MEASUREMENT OF GPS USER EQUIPMENT**
Joseph McGowan *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 17 p (For primary document see N87-29474 24-04)
Copyright Avail: NTIS HC A07/MF A01

A test program conducted by the U.S. Army Avionics Research and Development Activity (AVRADA) to determine the level of velocity accuracy achievable with Global Positioning System (GPS) is described. The precision of the reference instrumentation and the availability of the GPS receiver measurement data were exploited to characterize the errors in GPS observables. An investigation into the performance benefits of GPS and inertial integration is described. Author

**N87-29478#** Marconi Avionics Ltd., Rochester (England). Guidance Systems Div.
**A LOW COST GYROSCOPE FOR GUIDANCE AND STABILISATION UNITS c35**
D. G. Harris *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 9 p (For primary document see N87-29474 24-04)
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The potential requirements for a rugged moderate accuracy low cost gyro are very large, especially in smartening simpler weapons. Suitable candidate weapons are identified and a composite specification derived for gyroscopes that would satisfy the guidance and stabilization requirements. A development program is then described which is aimed at producing a suitable gyro by the combination of a well established principle for angular rate measurement and the latest materials and electronic techniques. A considerable effort was expended on basic experimental work before prototype batches of gyros were made. Results from the test of the later can survive cannon firing without performance degradation. This was demonstrated by informal tests with potential customers. The discipline of regular estimates of unit production cost was firmly maintained to avoid a major pitfall of sub-inertial quality gyro design. However, there are many past projects which bear witness to the fact that this is an unforgiving art and the necessity for continuous attention to detail must be maintained if the START design is to be successfully taken through to mass production. Author

**N87-29479#** Naval Air Development Center, Warminster, Pa. Strapdown Navigation Lab.
**JOINT DEVELOPMENT OF THE MULTI-FUNCTION INTEGRATED INERTIAL SENSOR ASSEMBLY (MIISA) c35**
Jack Jankovitz, David Krasnjanski, and Andrew S. Glista, Jr. (Naval Air Systems Command, Washington, D. C.) *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 9 p (For primary document see N87-29474 24-04)
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The U.S. Navy, Air Force, and Army are in the process of formalizing the joint service development and flight evaluation of the Multi-Function Integrated Inertial Sensor Assembly (MIISA).

The MIISA concept will provide a reliable, standardized, fault-tolerant, system which will serve as a common source of inertial data. MIISA wil provide data for flight control, navigation, weapon delivery, automatic terrain following terrain avoidance, sensor/tracker stabilization, flight instruments, and displays. A primary goal of this joint service activity is to resolve all technical issues and make this capability available for the next generation fighter and attack aircraft and for advanced helicopters. The Navy program to design, build, and evaluate an IISA Advanced Development Model was begun. To insure that the IISA is suitable for installation and flight test in an Air Force F-15, extensive laboratory testing will be undertaken at the NAVAIRDEVCEN Strapdown Navigation Laboratory. These tests involve the examination of IISA system performance for navigation and flight control. These tests are discussed. Author

**N87-29480#** Honeywell Advanced Technology Centre, North York (Ontario).

**CONFIGURATION DESIGN OF A HELICOPTER INTEGRATED NAVIGATION SYSTEM**

S. I. Fingerote, D. B. Reid, D. F. Liang, L. Vallot, C. Greene, and J. Mahesh (Honeywell Systems and Research Center, Minneapolis, Minn.) *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 9 p (For primary document see N87-29474 24-04)

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Results are presented from the configuration performance study phase of the Helicopter Integrated Navigation System project. A configuration assessment is presented including processor selection, and a discussion of system architecture and configuration tradeoffs leading to a recommended configuration. Results of the system error analysis and the Kalman filter design are presented demonstrating integrated system performance. Author

**N87-29481#** Litton Technische Werke, Freiburg (West Germany).

**NAVIGATION SYSTEMS FOR THE NEW GENERATION OF COMBAT AND TRANSPORT HELICOPTERS AND ASSOCIATED FLIGHT TESTS**

W. Hassenpflug and M. Baeumker *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 22 p (For primary document see N87-29474 24-04)

Copyright Avail: NTIS HC A07/MF A01

An integrated strapdown inertial helicopter navigator which is augmented by a Doppler velocity sensor and a magnetometer is described. A radar altimeter is used to obtain height above ground. Accurate weapon delivery requirements and flight safety aspects while operating the helicopter under adverse weather conditions and at night demand the accurate determination of TAS throughout the entire speed regime. Besides position, velocity, and attitude, the strapdown system provides angular rates for stability augmentation and linear accelerations in bodyframe coordinates, inertial altitude and vertical speed from the Doppler velocity sensor and the baro-inertial loop as well. The system communicates with the other avionics on board the helicopter through a duel MIL-STD 1553B bus and for redundancy purposes through an ARINC 429 interface with the AFCS. Flight tests were performed to demonstrate the navigation capability and performance of a Doppler and flux valve augmented strapdown navigator, a new analytical true air speed system for the low speed regime and the performance of a strapdown magnetometer. The navigation performance was verified in three different helicopters, a BO-105, a CH-53, and a Gazelle. Author

**N87-29482#** Rheinmetall G.m.b.H., Duesseldorf (West Germany). Guided Munition Dept.

**JET REACTION CONTROL SYSTEM FOR AUTONOMOUS PRECISION MUNITION c15**

H. Peller and S. Buechele-Buecher *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 18 p Original contains color illustrations (For primary document see N87-29474 24-04)

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The essential differences between missile and projectile application which are very important for actuations system designs are featured. A short trade study compares two methods of steering missiles and projectiles using aerodynamic or impulsive control, where the last mentioned one will be presented more exactly. The described hot gas reaction jet control actuation block is mounted in a submunition called EPHRAM which stands for terminal guided artillery munition. In this actuation system the gases produced by a gas generator are controlled by four individual thrusters. All these important and necessary components of a jet reaction control are explained and demonstrated by photographs and figures. Results of computer computation and simulation will finally verify that jet reaction control is the ideal application for such a cannon-launched guided projectile. Author

**N87-29483#** Naval Surface Weapons Center, Dahlgren, Va. Weapons Systems Dept.

**APPLICATION OF OPTIMAL ESTIMATION AND CONTROL CONCEPTS TO A BANK-TO-TURN MISSILE c15**

E. J. Ohlmeyer *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 12 p (For primary document see N87-29474 24-04)

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The design and evaluation of optimal estimators and optimal control laws for application to bank-to-turn missiles was addressed. Two guidance laws, one based on modern control theory and the other on an augmented form of proportional navigation, were compared to the classical implementation of proportional navigation. The former two control laws require the use of a state estimator. An extended Kalman filter was devised for that purpose. Performance of the three guidance laws was compared on the basis of average miss distance achieved for a number of engagement scenarios. Author

**N87-29484#** Norwegian Defence Research Establishment, Kjeller.

**AN INTELLIGENT MULTI-TARGET TRACKING SYSTEM c31**

E. Heyerdahl *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 9 p (For primary document see N87-29474 24-04)

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An implementation of a general tracking system, integrating the target acquisition and tracking subsystems, was developed. It is based on image analysis and extensive use of models. The system permits improvements compared to in-service trackers in the sense that it enables multi-target tracking, automatic acquisition also during tracking and tracking through obscurations. The system is an implementation of a general tracking system. This system produces alternative estimates of a target and projects the corresponding objects into the image plane. To do this estimates of the projecting function are used. The different projections are synthesized through a thresholding process. The implemented system uses parallel Kalman filters to produce the object estimates and estimates the sensor position through a model of sensor dynamics and measurements of sensor angle velocity. Results, produced by the implemented system from IR imagery of a moving target in field are presented. Author

**N87-29485#** Technische Hogeschool, Delft (Netherlands).

**PRECISION AND RELIABILITY OF A KALMAN FILTER Thesis [PRECISIE EN BETROUWBAARHEID VAN EEN KALMANFILTER]**

E. Hasenack 1986 119 p In DUTCH

(B8681151; ETN-87-90172) Avail: NTIS HC A06/MF A01

The precision and response characteristics of Kalman filters, and methods for the analysis of Kalman filters were studied. It is explained how the effect of certain types of error can be determined if the response of a Kalman filter is known. The verification of the solution calculated by the filter, the effects of undiscovered errors, and the reliability of the filter are discussed. ESA

**N87-29486#** Coast Guard Research and Development Center, Groton, Conn.
**LORAN-C SIGNAL STABILITY STUDY: WEST COAST Final Report**
D. S. Taggart and D. C. Slagle Dec. 1986 172 p
(AD-A183080; CGR/DC-08/85; USCG-D-4-87) Avail: NTIS HC A08/MF A01 CSCL 17G

Since the late 1970's the Coast Guard's Office of Research and Development has been investigating the stability characteristics of Loran-C in the Harbor/Harbor Approach (HHA) environment. This multi-year project, which had its beginnings in the St. Mary's River (a narrow waterway connecting Lake Huron and Lake Superior) has advanced to the point where it is now possible to model the repeatability characteristics on a chain-wide scale using a simple linear model and a finite set of Loran-C data observations. The model, which is called the Uniform Propagation Model, relies on a distance dependent variable (referred to as the Double-Range Difference or simply DRD) for minimization of the error term calculated by subtracting the modeled data from the observed data. The model's performance is improved by varying the weights assigned to various propagation paths. The resulting stability data is presented through the aid of computer generated contour diagrams. This report introduces the results obtained from software developed for this purpose. GRA

**N87-29487#** Federal Aviation Administration, Atlantic City, N.J.
**HELIPORT CRITICAL AREA FLIGHT TEST RESULTS**
Barry R. Billmann, Michael M. Webb, John G. Morrow, Donald W. Gallagher, and Christopher J. Wolf Feb. 1987 145 p
(AD-A183153; DOT/FAA/CT-TN86/64) Avail: NTIS HC A07/MF A01 CSCL 17G

The development of the microwave landing system (MLS) has resulted in the need for several different flight tests to optimize its utility. One such series of tests was designed to define criteria for siting MLS antennas at heliports. Due to the unique maneuver capabilities and the limited real estate available at heliports, flight tests were also conducted to determine the airspace and real estate surrounding the MLS antennas which must be protected when the MLS is sited at heliports. The need for this protected region is to guarantee signal coverage and quality. Based on the test flight results conducted at the Federal Aviation Administration (FAA) Technical Center, a minimum region (surrounding the MLS antennas and signal monitor poles) which must be protected is identified. GRA

**N87-29488#** Federal Aviation Administration, Atlantic City, N.J.
**TEST PLAN FOR HELICOPTER GPS (GLOBAL POSITIONING SYSTEM) APPLICATIONS**
Michael Magrogan May 1987 18 p
(AD-A183299; DOT/FAA/CT-TN87/16) Avail: NTIS HC A02/MF A01 CSCL 17G

This test plan describes a project designed to collect data via flight testing from the Global Positioning System (GPS) when receivers are mounted on helicopters. GPS issues to be investigated include antenna location, satellite shielding, and multipath influences which might occur with rotorcraft applications in urban downtown areas. Minimum masking angle issues will also be addressed. GPS integrated with other navigation and guidance systems such as Microwave Landing System (MLS) and Loran C will also be investigated. Both precision (P) and coarse/acquisition (C/A) code receivers will be evaluated. In addition, studies will be carried out to determine how to install a GPS antenna on composite body aircraft. Further studies may be related to automatic dependent surveillance functions. Future work will include evaluation of a GPS P code receiver as a reference for flight inspection. GRA

**N87-29489#** Defense Mapping Agency Aerospace Center, St. Louis, Mo.
**RECONCILING THE NAVIGATIONAL GRID WITH THE INERTIAL NAVIGATION SYSTEM**
Lori D. Wanner and John Hopkins Mar. 1987 16 p
(AD-A183461) Avail: NTIS HC A02/MF A01 CSCL 17G

The navigation grid overprinted on certain small scale navigation and planning charts published by the Defense Mapping Agency was originally intended for use in polar regions by navigators utilizing such techniques as celestial navigation and LORAN-C. The use of grid north gave the navigator a uniform reference direction to use rather than the highly convergent meridians. The concept of a non-changing north is remarkably like that encountered in an inertial navigation system with the local-level platform untorqued (alpha-wander mode). However, the directional angles computed by the inertial navigation system rapidly diverge from those measured from the charts. This paper explores the reason for this divergence and proposes a solution. Author (GRA)

# 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*. For land transportation vehicles see *85 Urban Technology and Transportation*.

**N87-29490** ESDU International Ltd., London (England).
**ESTIMATION OF SIDEFORCE, YAWING MOMENT AND ROLLING MOMENT DERIVATIVES DUE TO RATE OF ROLL FOR COMPLETE AIRCRAFT AT SUBSONIC SPEEDS**
Jun. 1985 34 p
(ESDU-85010; ISBN-0-85679-516-X; ISSN-0141-397X) Avail: ESDU

This Data Item #85010, an addition to the Aerodynamic Sub-series, discusses the application to the complete aeroplane of the prediction methods given for the contributions to the derivatives from wing planform and dihedral, and empennage. Illustrations show for diverse configurations at cruise the relative magnitudes of the contributions for each derivative, and comparisons with experimental data also show the effect of Mach number, incidence, wing sweep, and high lift devices. A detailed comparison of predictions with experimental data drawn from a wide range of sources including tunnel and flight results shows that the side force derivative is predicted to within 0.06, and the rolling moment derivative to within 10 percent. A comprehensive worked example shows the application of the methods. ESDU

**N87-29491*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**ANTICIPATION OF THE LANDING SHOCK PHENOMENON IN FLIGHT SIMULATION**
Richard E. McFarland Sep. 1987 17 p
(NASA-TM-89465; A-87237; NAS 1.15:89465) Avail: NTIS HC A02/MF A01 CSCL 01C

An aircraft landing may be described as a controlled crash because a runway surface is intercepted. In a simulation model the transition from aerodynamic flight to weight on wheels involves a single computational cycle during which stiff differential equations are activated; with a significant probability these initial conditions are unrealistic. This occurs because of the finite cycle time, during which large restorative forces will accompany unrealistic initial oleo compressions. This problem was recognized a few years ago at Ames Research Center during simulation studies of a supersonic transport. The mathematical model of this vehicle severely taxed computational resources, and required a large cycle time. The ground strike problem was solved by a described technique called anticipation equations. This extensively used technique has not been previously reported. The technique of anticipating a significant event is a useful tool in the general field of discrete flight simulation. For the differential equations representing a landing gear model stiffness, rate of interception and cycle time may combine to produce an unrealistic simulation of the continuum. Author

**N87-29492#** Naval Postgraduate School, Monterey, Calif.
**A CASE STUDY OF A COMBAT HELICOPTER'S SINGLE UNIT VULNERABILITY M.S. Thesis**

James W. Trueblood Mar. 1987 147 p
(AD-A183335) Avail: NTIS HC A07/MF A01 CSCL 01C

This thesis presents the methodology for a detailed vulnerability assessment of generic helicopter in the conceptual/preliminary design stage. The intent of this thesis is to provide a workable and understandable example of a vulnerability assessment. Towards that end, the single hit vulnerability of a helicopter to a 100 grain fragment is determined using the methodology presented in the textbook, The Fundamentals of Aircraft Combat Survivability Analysis and Design. GRA

**N87-29493#** Boeing Military Airplane Development, Seattle, Wash.
**FIGHTER AIRCRAFT OBIGGS (ON-BOARD INERT GAS GENERATOR SYSTEM) STUDY, VOLUME 1 Final Report, Jul. 1985 - Jan. 1987**
W. L. Vannice and A. F. Grenich Jun. 1987 125 p
(Contract F33615-85-C-2545)
(AD-A183690; D180-29904-1; AFWAL-TR-87-2024-Vol-1) Avail: NTIS HC A06/MF A01 CSCL 01C

The objective of this study was to develop a prototype development plan for installing the best choice OBIGGS in an Advanced Tactical Fighter (ATF). The best choice OBIGGS was based on detailed studies of inert gas requirements for ATF missions and trade-off studies to arrive at the best system preliminary design. Detailed specifications were defined for the best choice OBIGGS and life cycle cost studies were conducted to compare this OBIGGS with other fuel tank fire protection techniques. Results of the mission analysis and preliminary design studies are presented. GRA

**N87-29494#** Boeing Military Airplane Development, Seattle, Wash.
**FIGHTER AIRCRAFT OBIGGS (ON-BOARD INERT GAS GENERATOR SYSTEM) STUDY, VOLUME 2 Final Report, Jul. 1985 - Jan. 1987**
T. J. Howell Jun. 1987 197 p
(Contract F33615-85-C-2545)
(AD-A183781; D180-29904-2; AFWAL-TR-87-2024-Vol-2) Avail: NTIS HC A09/MF A01 CSCL 01C

The objective of this study was to develop a prototype development plan for installing the best choice OBIGGS in an Advanced Tactical Fighter (ATF). The best choice OBIGGS was based on detailed studies of inert gas requirements for ATF missions and trade-off studies to arrive at the best system preliminary design. Detailed specifications were defined for the best choice OBIGGS and life cycle cost studies were conducted to compare this OBIGGS with other fuel tank fire protection techniques. Results of the mission analysis and preliminary design studies are presented in Volume I; results of the other studies and the prototype development plan are in Volume II. GRA

**N87-29495#** Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
**FLIGHT EVALUATION OF THE UH-60A HELICOPTER WITH THE PITCH BIAS ACTUATOR CENTERED AND ELECTRICALLY DISCONNECTED Final Report, 4 Apr. 1985 - 2 Jul. 1986**
Reginald C. Murrell, Roy A. Lockwood, Robert A. Williams, Michael K. Herbst, and Gary L. Skinner Sep. 1986 279 p
(AD-A183954; USAAEFA-84-28) Avail: NTIS HC A13/MF A01 CSCL 01C

Testing was conducted to evaluate handling qualities of the UH-60A helicopter with the pitch bias actuator (PBA) centered and electrically disconnected and with various modes of automatic flight control system (AFCS) degradation. A total of 46.4 productive flight hours were flown between 4 April 1985 and 2 July 1986. Two shortcomings and two Prime Item Development Specification noncompliances were identified. The handling qualities of the UH-60A helicopter with the PBA centered and electrically disconnected are essentially unchanged from those with the PBA operational, except for: (1) slightly degraded static longitudinal stability, (2) slightly degraded dynamic stability, and (3) a shortcoming, the poor maneuvering stability characteristics. One additional shortcoming is the strong pitch-due-to-sideslip coupling. GRA

**N87-29496*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**THE RESULTS OF A WIND TUNNEL INVESTIGATION OF A MODEL ROTOR WITH A FREE TIP**
Robert H. Stroub and Larry A. Young Oct. 1985 176 p
(NASA-TM-86758; Rept-85266; NAS 1.15:86758) Avail: NTIS HC A09/MF A01 CSCL 01C

The results of a wind-tunnel test of the free tip rotor are presented. The free tip extended over the outer 10% of the rotor blade and included a simple, passive controller mechanism. Wind-tunnel test hardware is described. The free-tip assembly, which includes the controller, functioned flawlessly throughout the test. The tip pitched freely and responded to airflow perturbation in a sharp, quick, and stable manner. Tip pitch-angle responses are presented for an advance ratio range of 0.1 to 0.397 and for a thrust coefficient range of 0.038 to 0.092. The free tip reduced power requirements, loads going into the control system, and some flatwise blade-bending moments. Chordwise loads were not reduced by the free tip. Author

**N87-29497*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**QUALITATIVE EVALUATION OF A FLUSH AIR DATA SYSTEM AT TRANSONIC SPEEDS AND HIGH ANGLES OF ATTACK**
Terry J. Larson, Stephen A. Whitmore, L. J. Ehernberger, J. Blair Johnson, and Paul M. Siemers, III Washington NASA Apr. 1987 64 p
(NASA-TP-2716; H-1277; NAS 1.60:2716) Avail: NTIS HC A04/MF A01 CSCL 01C

Flight tests were performed on an F-14 aircraft to evaluate the use of flush pressure orifices on the nose section for obtaining air data at transonic speeds over a large range of flow angles. This program was part of a flight test and wind tunnel program to assess the accuracies of such systems for general use on aircraft. It also provided data to validate algorithms developed for the shuttle entry air data system designed at NASA Langley. Data were obtained for Mach numbers between 0.60 and 1.60, for angles of attack up to 26.0 deg, and for sideslip angles up to 11.0 deg. With careful calibration, a flush air data system with all flush orifices can provide accurate air data information over a large range of flow angles. Several orifices on the nose cap were found to be suitable for determination of stagnation pressure. Other orifices on the nose section aft of the nose cap were shown to be suitable for determination of static pressure. Pairs of orifices on the nose cap provided the most sensitive measurements for determining angles of attack and sideslip, although orifices located farther aft on the nose section could also be used. Author

**N87-29498*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**BIBLIOGRAPHY FOR AIRCRAFT PARAMETER ESTIMATION**
Kenneth W. Iliff and Richard E. Maine Oct. 1986 22 p
(NASA-TM-86804; H-1358; NAS 1.15:86804) Avail: NTIS HC A02/MF A01 CSCL 01C

An extensive bibliography in the field of aircraft parameter estimation has been compiled. This list contains definitive works related to most aircraft parameter estimation approaches. Theoretical studies as well as practical applications are included. Many of these publications are pertinent to subjects peripherally related to parameter estimation, such as aircraft maneuver design or instrumentation considerations. Author

**N87-29499*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
**APPLICATION OF PARAMETER ESTIMATION TO AIRCRAFT STABILITY AND CONTROL: THE OUTPUT-ERROR APPROACH**
Richard E. Maine and Kenneth W. Iliff Jun. 1986 175 p
Submitted for publication
(NASA-RP-1168; H-1299; NAS 1.61:1168) Avail: NTIS HC A08/MF A01 CSCL 01C

The practical application of parameter estimation methodology to the problem of estimating aircraft stability and control derivatives from flight test data is examined. The primary purpose of the document is to present a comprehensive and unified picture of the entire parameter estimation process and its integration into a flight test program. The document concentrates on the output-error method to provide a focus for detailed examination and to allow us to give specific examples of situations that have arisen. The document first derives the aircraft equations of motion in a form suitable for application to estimation of stability and control derivatives. It then discusses the issues that arise in adapting the equations to the limitations of analysis programs, using a specific program for an example. The roles and issues relating to mass distribution data, preflight predictions, maneuver design, flight scheduling, instrumentation sensors, data acquisition systems, and data processing are then addressed. Finally, the document discusses evaluation and the use of the analysis results. Author

**N87-29500*#** Pennsylvania Univ., Philadelphia. Dept. of Civil Engineering.
**A STRATEGY FOR ADVANCING TILT-ROTOR TECHNOLOGY Final Report**
Edward K. Morlok and David L. Schoendorfer Jun. 1985 82 p (Grant NAG2-305)
(NASA-CR-181420; NAS 1.26:181420) Avail: NTIS HC A05/MF A01 CSCL 01C

Tilt-rotor technology has many features which make it a very promising development in aviation which might have application to a wide variety of transportation and logistics situations. However, aside from military applications and rather specialized industrial applications, little is known regarding the potential of tilt-rotor for commercial transportation and hence it is difficult to plan a development program which would gain support and be likely to produce a stream of significant benefits. The purpose is to attempt to provide some of this information in a manner that would be useful for preparing a strategy for development of tilt-rotor aircraft technology. Specifically, the objectives were: to identify promising paths of development and deployment of tilt-rotor aircraft technology in the air transportation system considering both benefits and disbenefits, and to identify any particular groups that are likely to benefit significantly and propose plans for gaining their support of research and development of this technology. Potential advantages of the tilt-rotor technology in the context of air transportation as a door-to-door system were identified, and then promising paths of development of such tilt-rotor systems were analyzed. These then lead to recommendations for specific studies, information dissemination and development of awareness of the tilt-rotor among specific transport-related groups. Author

**N87-29501*#** Pennsylvania Univ., Philadelphia. Dept. of Civil Engineering.
**COST CHARACTERISTICS OF TILT-ROTOR, CONVENTIONAL AIR AND HIGH SPEED RAIL SHORT-HAUL INTERCITY PASSENGER SERVICE Final Report**
David L. Schoendorfer and Edward K. Morlok May 1985 113 p (Grant NAG2-305)
(NASA-CR-181421; NAS 1.26:181421) Avail: NTIS HC A06/MF A01 CSCL 01C

The cost analysis done to support an assessment of the potential for a small tilt-rotor aircraft to operate in short-haul intercity passenger service is described in detail. Anticipated costs of tilt-rotor air service were compared to the costs of two alternatives: conventional air and high speed rail (HSR). Costs were developed for corridor service, varying key market characteristics including distance, passenger volumes, and minimum frequency standards. The resulting cost vs output information can then be used to compare modal costs for essentially identical service quality and passenger volume or for different service levels and volumes for each mode, as appropriate. Extensive sensitivity analyses are performed. The cost-output features of these technologies are compared. Tilt-rotor is very attractive compared to HSR in terms of costs over the entire range of volume. It also has costs not dramatically different from conventional air, but tilt-rotor costs are generally higher. Thus some of its other advantages, such as the VTOL capability, must offset the cost disadvantage for it to be a preferred or competitive mode in any given market. These issues are addressed in the companion report which considers strategies for tilt-rotor development in commercial air service. Author

**N87-29502*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**TRIMMING AN AIRCRAFT MODEL FOR FLIGHT SIMULATION**
Richard E. McFarland Oct. 1987 32 p
(NASA-TM-89466; A-87238; NAS 1.15:89466) Avail: NTIS HC A03/MF A01 CSCL 01C

Real-time piloted aircraft simulations with digital computers have been performed at Ames Research Center (ARC) for over two decades. For the simulation of conventional aircraft models, the establishment of initial vehicle and control orientations at various operational flight regimes has been adequately handled by either analog techniques or simple inversion processes. However, exotic helicopter configurations have been introduced recently that require more sophisticated techniques because of their expanded degrees of freedom and environmental vibration levels. At ARC, these techniques are used for the backward solutions to real-time simulation models as required for the generation of trim points. These techniques are presented in this paper with examples from a blade-element helicopter simulation model. Author

# 06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

**N87-29503#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.
**INFORMATION MANAGEMENT AND DECISION MAKING IN ADVANCED AIRBORNE WEAPON SYSTEMS**
Feb. 1987 323 p In ENGLISH and FRENCH Symposium held in Toronto, Ontario, 15-18 Apr. 1986
(AGARD-CP-414; ISBN-92-835-0411-9) Copyright Avail: NTIS HC A14/MF A01

These conference proceedings focus on the significant human factors issues posed by the development of advanced aircrew stations incorporating new technologies such as adaptive and supervisory systems and multipurpose displays and computer graphics. Complimentary papers by members of the Avionics Panel focusing on the role of voice interactive systems and a summary of the findings of the Guidance and Control Panel's Working Group on Automation at the Man Machine Interface were also presented at the symposium. For individual titles, see N87-29504 through N87-29529.

**N87-29504#** Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
**AUTOMATION AT THE MAN-MACHINE INTERFACE** **c54**
Walter M. Hollister *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 19 p (For primary document see N87-29503 24-06)
see N87-29503 24-06)
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There is a recognized need for automation. However, detailed analysis shows that the term automation is too broad for making specific research recommendations. The specific characteristics vary in kind and degree as a function of the piloting tasks. In some cases, the task should be left entirely to the pilot. In many cases, computer aiding is the best choice. A method for allocating functions between automated systems and the pilot is presented using the theory of divided attention. It describes a structured approach for reducing the control dwell fraction with improved flying qualities. There is a need for fundamental research into the

understanding of how the human pilot operates as part of the aircraft and weapons control system. Author

**N87-29505#** Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France).
**STUDY OF ANTICIPATION MECHANISMS IN THE AERONAUTICAL ENVIRONMENT [ETUDE DES MECANISMES D'ANTICIPATION EN AERONAUTIQUE]** c53
R. Amalberti, Cl. Valot, and J.-P. Menu *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 14 p In FRENCH (For primary document see N87-29503 24-06)
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Pilot behavior during anticipation activities is discussed. These types of activities make use of the ability to mentally represent the result of changes produced in a given situation, allowing for related events and real action potentials. Anticipation activities may take place at various levels including initial mission planning and necessitated in-flight changes thereto, during the use of standard procedures to accomplish various flight maneuvers and other highly routine acts, and during the acquisition and transfer of information to and from the hardware system using its displays and controls. Both behavioral observation and interview techniques with experienced and inexperienced pilots were used to reveal the rules by which these anticipation activities are carried out and how they differ as a function of the specific knowledge of the pilot at a given point in time and the available time to consider alternate responses. M.G.

**N87-29506#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Helicopter and Military Aircraft Group.
**THE TASK TAXONOMY METHOD: A BASIS FOR AN EXPERT SYSTEM ON HUMAN RELIABILITY** c53
R. Seifert and K. Brauser *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 8 p (For primary document see N87-29503 24-06)
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A survey of human error (HE), its definition, nature of HE and the categorization of HE's, causes and prevention measures is described. Then a HE rating scale is introduced, which allows the assignment of HE probability (HEP) values measured into 10 reliability classes (RC). Based on HEP values measured for a number of human performances, a Task Taxonomy Method is developed. This method allows the assignment of a relative weight to all task factors and to all performance shaping factors involved in the task performance. The task taxonomy method is a tool to predict the HEP and RC of tasks allocated to man. Such a predictive tool is used for analysis, definition and design of man machine systems. Rules of an Expert System are described which facilitates the application and use of the task taxonomy method. Author

**N87-29507#** Washington Univ., St. Louis, Mo.
**CLOSING THE MAN-MACHINE LOOP: ON THE USE OF PHYSIOLOGICAL MEASURES TO AFFECT COMPUTER-CONTROLLED DEVICES** c54
J. A. Stern, G. F. Wilson, and M. Theissen (General Dynamics Corp., Fort Worth, Tex.) *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 5 p (For primary document see N87-29503 24-06)
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Results suggest that physiological information: heart rate, eye blink, etc., as well as information about operator performance and system characteristics, could be used to alert the operator, change displays, or permit the hardware to take over certain functions. Utilization of physiological data from the operator must be used with certain cautions in mind. For example, physical exertion causes changes in heart rate. The system would have to be provided with information concerning physical exertion, so that the heart rate data could be appropriately interpreted in a larger context. This is true of the information concerning aircraft performance as well, where the pattern of inputs from various sensors is analyzed in order to make a decision about an action to be taken. Author

**N87-29508*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**THE EFFECTS OF DISPLAY-CONTROL I/O, COMPATIBILITY, AND INTEGRALITY ON DUAL-TASK PERFORMANCE AND SUBJECTIVE WORKLOAD** c54
Pamela S. Tsang (Illinois Univ., Savoy.), Sandra G. Hart, and Michael A. Vidulich *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 9 p (For primary document see N87-29503 24-06)
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The utility of speech technology was evaluated in terms of three dual task principles: resource competition between the time shared tasks, stimulus central processing response compatibility, and task integrality. Empirical support for these principles was reviewed. Two studies investigating the interactive effects of the three principles were described. Objective performance and subjective workload ratings for both single and dual tasks were examined. It was found that the single task measures were not necessarily good predictors for the dual task measures. It was shown that all three principles played an important role in determining an optimal task configuration. This was reflected in both the performance measures and the subjective measures. Therefore, consideration of all three principles is required to insure proper use of speech technology in a complex environment.
Author

**N87-29509#** Royal Air Force, London (England).
**A STUDY OF PILOT FLIGHT INFORMATION CROSSMONITORING PERFORMANCE** c54
V. P. Schmit *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p (For primary document see N87-29503 24-06)
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A experiment is discussed which investigated the ability of the pilot to crossmonitor between Head Up display and Head Down instruments. In a situation with high error rates, no subsidiary tasks and with explicit exclusion of troubleshooting (i.e., a best case), results show a low error detection rate, long detection times and significant flying performance decrements while crossmonitoring. Error detection performance is correlated not with the amount of time spent crossmonitoring, but with the frequency at which the pilot chooses to crossmonitor. Extrapolation from the results suggests that, at least for the conditions of this experiment, crossmonitoring should occur every 22 to 23 sec to ensure acceptable error detection. The evidence points clearly to the need to remove the crossmonitoring task from the pilot and make it an automated function for future aircraft. Author

**N87-29510#** Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France).
**SOPHISTICATED INTEGRAL CONTROL METHODS FOR USE IN FLIGHT [LES MOYENS DE COMMANDE INTEGRES SOPHISTIQUES SERONT-ILS CONCUS POUR ETRE UTILISABLES EN VOL]** c54
J.-P. Menu, G. Santucci, and R. Amalberti *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 6 p In FRENCH (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

The changing nature of display and control requirements for modern aircraft and the various means by which information is transferred to and from the pilot are reviewed. Some of the known factors affecting human performance are discussed including: (1) desaturation and contrast loss in electronically generated information during high illumination inflight conditions; (2) the effects of high acceleration on both foveal and peripheral presentations of information; (3) manual control designs which obscure some settings when engaged; and (4) the improper labelling of display and control devices. The potential use of voice interactive control devices, especially in overcoming problems inherent in multitask situations, is also discussed. Finally, the relative merits of dedicated and multifunctional displays and controls are examined along with

the theoretical causes of increased higher cognitive workloads required by multifunction devices. M.G.

**N87-29511#** International Business Machines Corp., Gaithersburg, Md.

**STARS, POLYGONS AND CLUSTERS** **c82**

Robert O. Turek and Joel S. Greenstein (Clemson Univ., S.C.) *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 7 p (For primary document see N87-29503 24-06)

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One technique for displayig a set of quantitative variables is to represent the values graphically in the form of a polygon or star, allowing the observer to visually handle complex information quickly, as a whole. Such displays have been used in various areas, for data exploration and presentation, and in status displays; they are also suited to categorization and identification tasks. For polygon displays to be reliably used, they should be capable of being interpreted consistently. An experimental investigation was undertaken to ascertain the effect of variation in certain visual features of the display on the consistency with which untrained subjects categorize information presented as polygons. Variables included background information, shading of figures, and form. Subjects performed a categorization task on several sets of data; the results were analyzed on the basis of consistency between individuals and consistency with certain standard clustering algorithms. Implications for display design include the effects of distinctive patterns on similarity judgements, of the nature of the data represented, and of the interaction of variables. Author

**N87-29512#** Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio. Human Engineering Div.

**AN ASSESSMENT OF VARIABLE FORMAT INFORMATION PRESENTATION** **c82**

J. A. Forester *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 13 p (For primary document see N87-29503 24-06)

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Three experiments testing the feasibility of varying information display formats as task demands change in complex multitask environments were conducted. A multiple resource model of human information processing was used as a guide for determining how best to represent task relevant information under changing conditions and the general validity of certain aspects of the model was assessed. Experiment 1 investigated the usefulness of a basic dual task environment for testing the variable format approach and Experiment 2 demonstrated that the technique was successful under simple task conditions. Experiment 3 increased the complexity of the base dual task by including a third task in an adaptive system context. The results from Experiment 3 supported the use of variable formats in complex adaptive systems and were consistent with the tenets of multiple resource theory. Experiment 3 also indicated the importance of considering individual differences in the design of adaptive systems. The overall approach attempts to improve human processing efficiency by capitalizing on current knowledge of human information processing characteristics and capabilities. Author

**N87-29513#** Naval Aerospace Medical Research Lab., Pensacola, Fla.

**PERCEPTUAL PROCESSING CAPABILITIES RELEVANT TO DESIGN OF VISUAL DISPLAYS FOR INFORMATION MANAGEMENT IN ADVANCED AIRBORNE WEAPON SYSTEMS** **c82**

Tommy R. Morrison *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 9 p (For primary document see N87-29503 24-06)

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A review of P-3C Tactical Coordinator task analytic data provided the basis for developing an experimental paradigm for investigating cognitive processing demands characteristic of Naval aviation displays. Stepwise regression analyses of the obtained data provided assessment of processing times associated with the various display demands and regression equations for predicting performance. The results provide human performance data relevant to human factors and design engineers involved in developing visual displays to enhance information management in advance airborne weapon systems. Author

**N87-29514#** Royal Air Force Inst. of Aviation Medicine, Farnborough (England).

**PERCEPTUAL ORGANISATION AND INFORMATION MANAGEMENT** **c82**

R. M. Taylor *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 28 p (For primary document see N87-29503 24-06)

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The changing requirements for information processing and control and the development of the information management function are reviewed through the history of the aircraft cockpit. Information management was once entirely carried out by the pilot but now this function seems likely to be shared between the pilot and adaptive automation. Human information management begins with perceptual organization. Gestalt thinking on perceptual organization is reviewed with reference to the information processing approach to human cognition and in particular to the operations of selective attention, working memory and the linking of perception and thought. Perception can be facilitated through the design of information displays. The influence of the principles of perceptual organization on the design of the dialogue across the human machine interface is reviewed with particular reference to the integration and differentiation of flight information. Three experiments are reported that are relevant to the use of color as an organizational factor in complex pictorial computer generated displays. Author

**N87-29515#** Royal Aircraft Establishment, Farnborough (England). Flight Systems Dept.

**INFORMATION MANAGEMENT IN THE ARMY BATTLEFIELD HELICOPTER** **c82**

C. P. Gibson and D. Williams *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 13 p (For primary document see N87-29503 24-06)

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Considerable experience in the design of mission management systems has been gained in recent years. Flight trials have shown that careful design of these systems can result in considerable time savings in executing many of the tasks performed by the crew during tactical operations. In addition, flight trials were also conducted to evaluate the potential benefits of a simple tactical situation display presented on a color cathode ray tube. These trials have given valuable insight into the applications and requirements of this type of display. The experience gained was applied to the development of a complete system for installation in a helicopter with a MIL STD 1553b databus avionics system to enable further flight trials addressing system integration and man machine interface optimization. A flexible ground station was also developed to allow investigation of optimizing methods for premission programming of the system and tactical situation display via a solid state data transfer device. Author

**N87-29516#** Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France). Lab. Central de Biologie Aerospatiale.

**ORGANIZATION OF DISPLAYS IN THE VISUAL SPACE OF THE COMBAT AIRCRAFT PILOT [ORGANISATION DES VISUALISATIONS DANS L'ESPACE VISUEL DU PILOTE D'AVION DE COMBAT]** **c54**

J.-P. Menu and R. Amalberti *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p (For primary document see N87-29503 24-06)

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The psychophysiological problems associated with the specific organization of cockpit displays were examined through laboratory studies and pilot surveys. The response time associated with the transition between head-up and head-down displays was measured under various conditions. It was found that reduced transition times could be obtained through the use of intermediate display concepts. Illumination level and visual adaptation were identified as important factors in the optimal integration of displays. M.G.

**N87-29517#** Mitre Corp., Bedford, Mass.
**ADVANCED INFORMATION MANAGEMENT AND DECISION MAKING IN AIRBORNE EARLY WARNING AND CONTROL (AEW&C) TRAINING SYSTEMS** **c82**
L. M. Rosa, E. L. Estochen, J. L. Bottomley, and M. J. Hebert *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p (For primary document see N87-29503 24-06)
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Fundamental concepts are developed for the application of information management and artificial intelligence-based decision making technology to current and future surveillance, command, control and communication training systems. Specific emphasis is placed upon Airborne Early Warning and Control (AEW&C) training systems using the E-3 Mission Simulator as the analysis example. Present Mission Simulator capabilities are discussed along with ongoing improvement programs. Training inadequacies and instructor workload problems are highlighted. Advanced information management and artificial intelligence techniques are proposed to overcome these and other training deficiencies and to increase instructor efficiency. Extensions of these techniques for operational system use are also presented. Author

**N87-29518#** Hazeltine Corp., Greenlawn, N. Y. Adaptive Systems Lab.
**INCREASING THE USEFULNESS OF AWACS DOWNLINK TRANSMISSIONS BY SEMANTIC COMPRESSION** **c32**
Bonnie Schnitta-Israel and Roy S. Freedman *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 4 p (For primary document see N87-29503 24-06)
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Preliminary investigation of the data compression by semantic techniques via an automated resource allocation system based on AWACS operator expertise indicates improvement would occur to down link data transmission for C 2 missions. In essence this improvement is obtained by improving the timeliness of information transmission through knowledge directed allocation. In order to specify a complete system, a list of tasks which should be considered are listed. Author

**N87-29519#** Army Avionics Research and Development Activity, Fort Monmouth, N. J.
**INTEGRATING AVIONICS SENSOR SIGNALS FOR TACTICAL AIRCRAFT**
Barbara A. Bernabe and John J. Ward (Smiths Industries Ltd., Bishops Cleeve, England ) *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 10 p (For primary document see N87-29503 24-06)
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Current tactical aircraft must be prepared to operate in more severe threat environments than ever before. Stealth relies on conducting missions at night, at low levels, and at high speeds. Despite these adverse mission constraints, successful pilotage requires the aviator to continuously and accurately assess his own aircraft position in relation to surrounding landform configurations for navigation, for obstacle avoidance, and for masking, cover, and concealment. To assist the aviator in managing mission specific information, tactical aircraft are increasingly being equipped with sophisticated data gathering, storage, and processing systems. Data generated by these systems can be of two forms. One is that of video or digital spacially formatted images generated by an onboard sensor or processor. Typically the image represents the environmental situation surrounding the aircraft or at some remote location and is usually presented via a CRT. The other is that of alphanumeric codes which represent coodinates, elevations, ranges, or description of critical tactical locations. Typically this information is presented to the aviator via a control display unit (CDU). Conventionally, the aviator integrates and interprets the raw data output from these systems, for pilotage, tactical assessment, and decision making. Author

**N87-29520#** Naval Ocean Systems Center, San Diego, Calif.
**RAPID PROTOTYPING OF USER-COMPUTER INTERFACES DURING SYSTEM DESIGN** **c60**
G. A. Osga *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 10 p (For primary document see N87-29503 24-06)
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Rapid Prototyping is a process of creating a simulation of a user interface to a completed computer system, early in the design process, before the underlying or application software is developed. This process allows the presentation of display formats and system procedures to users early in the design process, allowing for behavioral data collection and numerous iterations in the user computer interface (UCI) design. The development and use of rapid prototyping software in an expert system development project is discussed. The user interface is a high resolution screen with multiple windows, using a mouse as the primary input device. A design procedure for an interface to an expert system is discussed which includes: (1) an Interface Design Tool, (2) an interface design checklist, and (3) the collection of and analysis of behavioral data during interface testing. Author

**N87-29521#** British Aerospace Aircraft Group, Preston (England). Advanced Systems Dept.
**A GRAPHICAL AID TO IKBS PROGRAM DEVELOPMENT** **c61**
P. J. Kearney and B. Hunt *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 18 p (For primary document see N87-29503 24-06)
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Intelligent Knowledge Based Systems (IKBS) developments fall into 2 categories: real time airborne applications of system automation and tactical decision aid type, and ground based expert systems. The first of these presents major difficulties with regard to Quality Assurance testing of the codes produced, while the second suffers from the inappropriateness of stand alone workstations and classical artificial intelligence (AI) approaches within the industrial aerospace context. British Aerospace is applying its extensive experience in conventional software methodologies to the new demands presented by IKBS, both to the developer and the user. One of the tools under development is known as GRIN (Graphical Representation of an Inference Network) and is described, together with an overview of an approach to AI. GRIN presents an inference network in a dynamic diagrammatic form, which maximizes the user's comprehension of the knowledge base, and hence eases development and maintenance of an IKBS. It is considered that this tool and the philosophy behind it will reinforce the view that IKBS represents a natural extension of programming technology rather than a radical change. Author

**N87-29522#** National Aeronautical Establishment, Ottawa (Ontario).
**SPEECH IS MORE THAN JUST AN AUDIBLE VERSION OF TEXT** **c32**
Melvyn J. Hunt *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p (For primary document see N87-29503 24-06)
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Man machine communication by text using keyboards and screens is much more firmly established than voice I/O. Partly

because of this, voice tends to be regarded as an audible version of text. This view is misleading: it leads to an underestimation of both the difficulties and the potential of voice I/O. Speech encodes information on factors such as speaker identity and attitude and sentence structure in ways that have no counterpart in text. The style of language appropriate for speech is quite different from that appropriate for text. Speech output and input systems tend to ignore those aspects of the speech signal that are not directly represented in text, and they frequently use a style and syntax suited to text rather than speech. In the case of speech output, the technology needed to exploit the additional aspects of the speech signal is already appearing, and recordings illustrating the possibilities are available. In the case of speech output, the technology is not yet developed, but the ability to manipulate features such as voice quality in speech output systems may be a powerful tool in learning how to exploit such features in speech input systems. Author

**N87-29523#** Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France).

**VOICE COMMAND AND THE CHANGE OF MENTAL REPRESENTATION DURING TASK PERFORMANCE [COMMANDE VOCALE ET CHANGEMENT DE REPRESENTATION MENTALE DANS LA TACHE]** **c32**

R. Amalberti, D. Batejat, and J.-P. Menu *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 10 p In FRENCH (For primary document see N87-29503 24-06)

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A two task experiment was performed to assess the distribution of mental resources and the competition between mental and speaking resources during task performance. The experiment was designed so that a primary surveillance/detection task was performed along with a secondary task involving the input of flight related information by either keyboard or voice command. Detection time was measured for the primary task and accuracy was determined for both the primary and secondary tasks. Quantitative results show that the use of voice command favors the performance of the primary surveillance task, but, for the secondary task, the voice input was less accurate than the manual keyboard input. Qualitative results with regard to pilot visual comportment and vocal errors are also discussed. M.G.

**N87-29524#** Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).

**LAYERED PROTOCOLS IN VOICE INTERACTION WITH COMPUTERS** **c32**

M. M. Taylor *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p (For primary document see N87-29503 24-06)
N87-29503 24-06)

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The Layered Protocol model for human computer interfaces is described, with special reference to the problems of voice input and output. In a layered protocol, each level passes virtual messages back and forth between human and computer. These virtual messages are realized in the form of interchanges at the level below. The protocol at a level is analogous to the syntax of a sentence, in that it is the method by which the content of a message can be given an agreed interpretation. Each protocol can be designed or evaluated independently of all the others in an interface. The stability of a protocol is determined by its response delays and by the channel capacity of the lower level protocols that support its messages. Sometimes an unstable protocol can be stabilized and speeded by reducing the message rate of the supporting protocols. Users have been observed to do this intuitively. Voice input provides special problems because of the relatively high error probability inherent in the recognizer: errors in other modalities are likely to be due to operator fault. This tends to lead to unwarranted distrust of voice input, and to demands for types of feedback that are probably inappropriate to the level of protocol to which the recognizer is suited. Voice output can be used by the computer to initiate protocols, or to provide a response channel for protocols under conditions where the user's eyes are otherwise occupied. Consideration of protocol demands helps to clarify the requirements for precision in recognition, and for the characteristics of computer responses to voice input; it helps also in judging appropriate conditions for the use of voice output. Author

**N87-29525#** University of Southern California, Los Angeles. Dept. of Safety and Systems Management.

**THE ROLE OF ASYMMETRIC TRANSFER IN THE EVALUATION OF VOICE GENERATION AND RECOGNITION SYSTEMS** **c32**

D. L. Damos *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 8 p (For primary document see N87-29503 24-06)

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The results of five experiments examining the effect of voice generation and recognition systems on dual task performance are presented. The extent to which asymmetric transfer biased the data in three of these experiments is determined by using statistical techniques and by comparing the data to the results of between subjects experiments. Generally, subjects performed task combinations better when stimuli for one of the tasks was presented auditorily using a voice generation system rather than visually on a display screen. In contrast, the use of a voice recognition system did not result in better dual task performance than the use of more conventional input devices. Author

**N87-29526#** British Aerospace Aircraft Group, Preston (England).

**VOICE CONTROL OF COCKPIT SYSTEMS** **c08**

P. Beckett *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 8 p Sponsored by Royal Aircraft Establishment, Farnborough, England (For primary document see N87-29503 24-06)

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The use of automatic speech recognition for cockpit management should allow more operations to be carried out head-up. In turn this should reduce the frequency and length of the periods spent looking into the cockpit. This would be particulary beneficial for the single seat pilot who could benefit from maintaining visual contact with a target or cooperating aircraft. In addition, it should generally allow more accurate flying performance and reduce the risk of collision with the ground or other aircraft. In order to assess these anticipated advantages, a simulator trial was set up at British Aerospace where a conventionally operated advanced fighter cockpit, containing electronic displays, was compared with one where Direct Voice Input (DVI) took over some of the roles normally carried out by tactile controls. The comparison was made during a simulated low level mission containing a cross section of typical cockpit activities. The comparison is discussed in detail. Author

**N87-29527#** Royal Aircraft Establishment, Bedford (England).

**THE FLIGHT EVALUATION OF A SPEECH RECOGNITION AND A SPEECH OUTPUT SYSTEM IN AN ADVANCED COCKPIT DISPLAY AND FLIGHT MANAGEMENT SYSTEM FOR HELICOPTERS**

R. Little *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p (For primary document see N87-29503 24-06)
24-06)

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A Wessex helicopter at RAE Bedford was used to develop and evaluate a set of electronic cockpit displays and a comprehensive suite of avionics which were integrated to form an advanced display and flight management system for both military and civil applications. Two important features of the system were automatic speech recognition and synthetic speech output. Flight trials were conducted to determine the ground rules and principles pertinent to the successful integration of these devices with other advanced avionics. The trial has shown that the combination of speech recognition and synthetic voice systems offers an element of redundancy and if correctly integrated into the cockpit will be

capable of improving the man machine interface to a far greater degree than is achievable by hand or voice alone. Author

**N87-29528#** Institute for Perception RVO-TNO, Soesterberg (Netherlands).
**VOICE INTERACTIVE SYSTEMS IN SEVERE NOISE CONDITIONS** c32
J. H. M. Steeneken and G. Langhout *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 6 p (For primary document see N87-29503 24-06)
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In a comparison of word recognition performance between human listeners and automatic speech recognition systems (ASR), the human listeners performs much better, especially in severe noise conditions. An application engineer can try to optimize the performance of an ASR system by selecting the optimal noise cancelling microphone and vocabulary for voice input. Some results from a study on the effect of signal handling and vocabulary configuration on the performance of voice input and voice output systems are discussed. Author

**N87-29529#** Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
**EFFECT OF AUDIO BANDWIDTH AND BIT ERROR RATE ON PCM, ADPCM AND LPC SPEECH CODING ALGORITHM INTELLIGIBILITY** c32
Richard L. McKinley and Thomas J. Moore *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 7 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

The effects of audio bandwidth and bit error rate on speech intelligibility of voice coders in noise are described and quantified. Three different speech coding techniques were investigated, pulse code modulation (PCM), adaptive differential pulse code modulation (ADPCM), and linear predictive coding (LPC). Speech intelligibility was measured in realistic acoustic noise environs by a panel of 10 subjects performing the Modified Rhyme Test. Summary data is presented along with planned future research in optimization of audio bandwidth vs bit error rate tradeoff for best speech intelligibility. Author

**N87-29530*#** IBM Federal Systems Div., Houston, Texas.
**THE DEVELOPMENT PROCESS FOR THE SPACE SHUTTLE PRIMARY AVIONICS SOFTWARE SYSTEM**
T. W. Keller 1987 87 p Prepared for presentation at the Common Conference, Chicago, Ill., 20 Oct. 1987
(Contract NAS9-16920)
(NASA-CR-180425; NAS 1.26:180425) Avail: NTIS HC A05/MF A01 CSCL 01D

Primary avionics software system; software development approach; user support and problem diagnosis; software releases and configuration; quality/productivity programs; and software development/production facilities are addressed. Also examined are the external evaluations of the IBM process. B.G.

**N87-29531*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**A VECTOR-BASED FAILURE DETECTION AND ISOLATION ALGORITHM FOR A DUAL FAIL-OPERATIONAL REDUNDANT STRAPDOWN INERTIAL MEASUREMENT UNIT**
Frederick R. Morrell and Melvin L. Bailey (PRC Kentron, Inc., Hampton, Va.) Sep. 1987 46 p
(NASA-TM-100493; NAS 1.15:100493) Avail: NTIS HC A03/MF A01 CSCL 01D

A vector-based failure detection and isolation technique for a skewed array of two degree-of-freedom inertial sensors is developed. Failure detection is based on comparison of parity equations with a threshold, and isolation is based on comparison of logic variables which are keyed to pass/fail results of the parity test. A multi-level approach to failure detection is used to ensure adequate coverage for the flight control, display, and navigation avionics functions. Sensor error models are introduced to expose the susceptibility of the parity equations to sensor errors and physical separation effects. The algorithm is evaluated in a simulation of a commercial transport operating in a range of light to severe turbulence environments. A bias-jump failure level of 0.2 deg/hr was detected and isolated properly in the light and moderate turbulence environments, but not detected in the extreme turbulence environment. An accelerometer bias-jump failure level of 1.5 milli-g was detected over all turbulence environments. For both types of inertial sensor, hard-over, and null type failures were detected in all environments without incident. The algorithm functioned without false alarm or isolation over all turbulence environments for the runs tested. Author

**N87-29532#** Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.
**EVALUATION OF THE F/A-18 HEAD-UP-DISPLAY FOR RECOVERY FROM UNUSUAL ATTITUDES Final Report**
Jerry Guttman Oct. 1986 48 p
(AD-A183303; NADC-86157-60) Avail: NTIS HC A03/MF A01 CSCL 01D

Maintaining situational awareness is a critical task in piloting an aircraft. Focusing on spatial orientation, the attitude displays provide information necessary for the pilot to control the aircraft's position in space. In the F/A-18 aircraft the Head-Up-Display (HUD) is the primary attitude indicator. This study compared electrically drawn attitude direction indicator (ADI), the current F/A-18 HUD, and the concurrent use of the ADI and HUD for recovery from unusual attitudes. Results indicated significantly faster recovery times for the ADI. Reasons may be attributed to the superiority of the color coding of the ADI for sky and ground over the dashed and solid pitch lines used for ground/sky coding on the HUD format. Pilot preferences were split between using the ADI as a convenient crosscheck and reduction of visual workload when using the HUD and ADI concurrently compared to using the HUD alone. The results from this study, which employed an electrically drawn ADI, parallel those found in earlier experiments comparing an electromechanical ADI to the F/A-18 HUD. They suggest that a centrally located ADI in the F/A cockpit would aid pilots during unusual attitude recovery. GRA

**N87-29533*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**ANALOG SIGNAL CONDITIONING FOR FLIGHT-TEST INSTRUMENTATION**
Donald W. Veatch and Rodney K. Bogue Washington NASA Jan. 1986 173 p Presented at the AGARD Flight Mechanics Panel, Flight-test Techniques Working Group, AGARDograph 160, Flight-Test Instrumentation Series Previously announced as N86-29816
(NASA-RP-1159; H-1191; NAS 1.61:1159) Avail: NTIS HC A08/MF A01 CSCL 01D

The application of analog signal conditioning to flight-tests data acquisition systems is discussed. Emphasis is placed on practical applications of signal conditioning for the most common flight-test data-acquisition systems. A limited amount of theoretical discussion is included to assist the reader in a more complete understanding of the subject matter. Nonspecific signal conditioning, such as amplification, filtering, and multiplexing, is discussed. Signal conditioning for various specific transducers and data terminal devices is also discussed to illustrate signal conditioning that is unique to particular types of transducers. The purpose is to delineate for the reader the various signal-conditioning technique options, together with tradeoff considerations, for commonly encountered flight-test situations. Author

# 07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

**N87-29534*#** General Electric Co., Cincinnati, Ohio. Aircraft Enginer Business Group.

**AERODYNAMIC PERFORMANCE INVESTIGATION OF ADVANCED MECHANICAL SUPPRESSOR AND EJECTOR NOZZLE CONCEPTS FOR JET NOISE REDUCTION Final Report, 1981-1984**

C. D. Wagenknecht and E. D. Bediako Feb. 1985 218 p
(Contract NAS3-23038)
(NASA-CR-174860; NAS 1.26:174860; R83AEB122-3) Avail: NTIS HC A10/MF A01 CSCL 21E

Advanced Supersonic Transport jet noise may be reduced to Federal Air Regulation limits if recommended refinements to a recently developed ejector shroud exhaust system are successfully carried out. A two-part program consisting of a design study and a subscale model wind tunnel test effort conducted to define an acoustically treated ejector shroud exhaust system for supersonic transport application is described. Coannular, 20-chute, and ejector shroud exhaust systems were evaluated. Program results were used in a mission analysis study to determine aircraft takeoff gross weight to perform a nominal design mission, under Federal Aviation Regulation (1969), Part 36, Stage 3 noise constraints. Mission trade study results confirmed that the ejector shroud was the best of the three exhaust systems studied with a significant takeoff gross weight advantage over the 20-chute suppressor nozzle which was the second best. Author

**N87-29535*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**STEADY-STATE PERFORMANCE OF A TURBOFAN/TURBOSHAFT CONVERTIBLE ENGINE WITH VARIABLE INLET GUIDE VANES**

Jack G. McArdle, Richard L. Barth, and Leo A. Burkardt Jul. 1987 33 p
(NASA-TP-2673; E-3250; NAS 1.60:2673) Limited by ITAR CSCL 21E

A convertible engine with variable inlet guide vanes (VIGV) that closed to unload the fan aerodynamically in the turboshaft power mode was tested on an outdoor static test stand. A waterbrake was used for the shaft load. The engine was a modified General Electric TF34-400B called the CEST TF34. The engine produced up to 7950 lb. of thrust with the VIGV open and 4650 hp of shaft power plus 1650 lb. of thrust with the VIGV fully closed. The residual thrust was mainly from the core engine. With closed VIGV the engine lost as much as 2200 hp in churning and heating the airflow through the fan tip. In the dual power mode (combined fan and shaft power) the engine ran stably and smoothly everywhere in the envelope bounded by turbofan and turboshaft mode performance, except for a small region of fan-tip aeromechanical instability. The success of these tests demonstrated that this type of engine should be considered for applications needing both thrust and shaft power. In addition to overall engine performance, internal flow path data were obtained to evaluate the characteristics and operation of new and modified engine components. Typical results are presented for the fan-tip variable exit guide vanes, for the core-to-bypass bleed valve, and for important or unusual airflow behavior at the fan hub and tip. Author

**N87-29536*#** Lockheed-Georgia Co., Marietta.

**PROPFAN TEST ASSESSMENT PROPFAN PROPULSION SYSTEM STATIC TEST REPORT Contractor Report, Feb. - Jun. 1986**

D. M. ORourke Sep. 1987 238 p
(Contract NAS3-24339)
(NASA-CR-179613; NAS 1.26:179613; LG86ER0173; L87R1488) Avail: NTIS HC A11/MF A01 CSCL 21E

The propfan test assessment (PTA) propulsion system successfully completed over 50 hours of extensive static ground tests, including a 36 hour endurance test. All major systems performed as expected, verifying that the large-scale 2.74 m diameter propfan, engine, gearbox, controls, subsystems, and flight instrumentation will be satisfactory with minor modifications for the upcoming PTA flight tests on the GII aircraft in early 1987. A test envelope was established for static ground operation to maintain propfan blade stresses within limits for propfan rotational speeds up to 105 percent and power levels up to 3880 kW. Transient tests verified stable, predictable response of engine power and propfan speed controls. Installed engine TSFC was better than expected, probably due to the excellent inlet performance coupled with the supercharging effect of the propfan. Near- and far-field noise spectra contained three dominant components, which were dependent on power, tip speed, and direction. The components were propfan blade tones, propfan random noise, and compressor/propfan interaction noise. No significant turbine noise or combustion noise was evident. Author

**N87-29537*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**AIRFLOW CALIBRATION AND EXHAUST PRESSURE/TEMPERATURE SURVEY OF AN F404, S/N 215-109, TURBOFAN ENGINE**

Maureen E. Burns and Thomas A. Kirchgessner Sep. 1987 31 p
(NASA-TM-100159; E-3447; NAS 1.15:100159) Avail: NTIS HC A03/MF A01 CSCL 21E

A General Electric F-404 turbofan engine was calibrated for thrust and airflow at the NASA Lewis Propulsion System Laboratory in support of future flight tests of the X-29 aircraft. Tests were conducted with and without augmentation, over a range of flight conditions, including the two design points of the airplane. Data obtained during the altitude tests will be used to correct two independent gross thrust calculation routines which will be installed and operated on the airplane to determine in-flight gross thrust. Corrected airflow data as a function of corrected fan speed collapsed onto a single curve. Similarly, trends were observed and defined for both augmented and dry thrust. Overall agreement between measured data and F-404 Engine Spec Deck data was within 2 percent for airflow and 6 percent for thrust. The results of an uncertainty analysis for thrust and airflow is presented. In addition to the thrust calibration, the exhaust gas boundary layer pressure and temperatures were surveyed at selected condition and engine power levels to obtain data for another NASA F-404 program. Test data for these surveys are presented. Author

**N87-29538*#** General Electric Co., Cincinnati, Ohio.

**TURBOFAN AFT DUCT SUPPRESSOR STUDY. CONTRACTOR'S DATA REPORT OF MODE PROBE SIGNAL DATA Final Report**

G. H. Fiske, R. E. Motsinger, A. A. Syed, M. C. Joshi, and R. E. Kraft (Douglas Aircraft Co., Inc., Long Beach, Calif.) Jul. 1983 74 p
(Contract NAS3-22766)
(NASA-CR-175067; NAS 1.26:175067) Avail: NTIS HC A04/MF A01 CSCL 21E

Acoustic modal distributions were measured in a fan test model having an annular exhaust duct for comparison with theoretically predicted acoustic suppression values. This report contains the amplitude and phase data of the acoustic signals sensed by the transducers of the two mode probes employed in the measurement. Each mode probe consisted of an array of 12 transducers sensing the acoustic field at three axial positions and four radial positions. M.G.

**N87-29539*#** General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.

**TURBOFAN AFT DUCT SUPPRESSOR STUDY**

A. A. Syed, R. E. Motsinger, G. H. Fiske, M. C. Joshi, and R. E. Kraft (Douglas Aircraft Co., Inc., Long Beach, Calif.) Jul. 1983 202 p
(Contract NAS3-22766)
(NASA-CR-175067; NAS 1.26:175067; R83AEB566) Avail: NTIS HC A10/MF A01 CSCL 21E

Suppressions due to acoustic treatment in the annular exhaust duct of a model fan were theoretically predicted and compared with measured suppressions. The predictions are based on the modal analysis of sound propagation in a straight annular flow duct with segmented treatment. Modal distributions of the fan noise source (fan-stator interaction only) were measured using in-duct modal probes. The flow profiles were also measured in the vicinity of the modal probes. The acoustic impedance of the single degree of freedom treatment was measured in the presence of grazing flow. The measured values of mode distribution of the fan noise source, the flow velocity profile and the acoustic impedance of the treatment in the duct were used as input to the prediction program. The predicted suppressions, under the assumption of uniform flow in the duct, compared well with the suppressions measured in the duct for all test conditions. The interaction modes generated by the rotor-stator interaction spanned a cut-off ratio range from nearly 1 to 7. Author

**N87-29540** California Univ., Los Angeles.
**THIN-FILM TEMPERATURE SENSORS FOR GAS TURBINES Ph.D. Thesis**
Shiva Prakash 1987 168 p
Avail: Univ. Microfilms Order No. DA8713859

Technology for the fabrication of thin-film temperature sensors on turbine blades that would remain adherent and at the same time function accurately under operating conditions was developed. The sensor system, essentially a thin-film thermocouple, consists of a multilayered coating structure where the critical aspects include adherence and purity of layers, electrical insulation, and interfacial stability at high temperatures, among numerous others that had to be evaluated and optimized. The Activated Reactive Evaporation process for the development of a pure, defect-free, insulating oxide layer was found effective, and vacuum treatment was also found effective for increasing adherence. Thermo-emf data show that the thin-film thermocouples perform rather well with negligible drift at high temperatures. The barrier layers proved effective in reducing the oxidation of rhodium. Interdiffusion and compound formation were studied in the Pt/Si3N4 and Pt/Si(x)ON(y) systems, and results indicated that Al2O3 is a better choice as a barrier layer compared to silicon-containing ceramics. Dissert. Abstr.

# 08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

**N87-29541*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**A PILOTED SIMULATION OF HELICOPTER AIR COMBAT TO INVESTIGATE EFFECTS OF VARIATIONS IN SELECTED PERFORMANCE AND CONTROL RESPONSE CHARACTERISTICS**
Michael S. Lewis, M. Hossein Mansur (Army Aviation Research and Development Command, Moffett Field, Calif.), and Robert T. N. Chen Aug. 1987 98 p
(NASA-TM-89438; A-87147; NAS 1.15:89438; USAAVSCOM-TM-87-A-3) Avail: NTIS HC A05/MF A01 CSCL 01C

A piloted simulation study investigating handling qualities and flight characteristics required for helicopter air to air combat is presented. The Helicopter Air Combat system was used to investigate this role for Army rotorcraft. Experimental variables were the maneuver envelope size (load factor and sideslip), directional axis handling qualities, and pitch and roll control-response type. Over 450 simulated, low altitude, one-on-one engagements were conducted. Results from the experiment indicate that a well damped directional response, low sideforce caused by sideslip, and some effective dihedral are all desirable for weapon system performance, good handling qualities, and low pilot workload. An angular rate command system was favored over the attitude type pitch and roll response for most applications, and an enhanced maneuver envelope size over that of current generation aircraft was found to be advantageous. Pilot technique, background, and experience are additional factors which had a significant effect on performance in the air combat tasks investigated. The implication of these results on design requirements for future helicopters is presented. Author

**N87-29542*#** Systems Technology, Inc., Hawthorne, Calif.
**SPACE SHUTTLE FLYING QUALITIES AND CRITERIA ASSESSMENT Final Report**
T. T. Myers, D. E. Johnston, and Duane T. McRuer Mar. 1987 204 p
(Contract NAS2-11900)
(NASA-CR-4049; NAS 1.26:4049) Avail: NTIS HC A10/MF A01 CSCL 01C

Work accomplished under a series of study tasks for the Flying Qualities and Flight Control Systems Design Criteria Experiment (OFQ) of the Shuttle Orbiter Experiments Program (OEX) is summarized. The tasks involved review of applicability of existing flying quality and flight control system specification and criteria for the Shuttle; identification of potentially crucial flying quality deficiencies; dynamic modeling of the Shuttle Orbiter pilot/vehicle system in the terminal flight phases; devising a nonintrusive experimental program for extraction and identification of vehicle dynamics, pilot control strategy, and approach and landing performance metrics, and preparation of an OEX approach to produce a data archive and optimize use of the data to develop flying qualities for future space shuttle craft in general. Analytic modeling of the Orbiter's unconventional closed-loop dynamics in landing, modeling pilot control strategies, verification of vehicle dynamics and pilot control strategy from flight data, review of various existent or proposed aircraft flying quality parameters and criteria in comparison with the unique dynamic characteristics and control aspects of the Shuttle in landing; and finally a summary of conclusions and recommendations for developing flying quality criteria and design guides for future Shuttle craft. Author

**N87-29526#** British Aerospace Aircraft Group, Preston (England).
**VOICE CONTROL OF COCKPIT SYSTEMS**
P. Beckett *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 8 p Sponsored by Royal Aircraft Establishment, Farnborough, England (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

# 09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

**N87-29543*#** Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
**SOME PROPOSED ENHANCEMENTS TO THE NASA LANGLEY 13-INCH MAGNETIC SUSPENSION AND BALANCE SYSTEM Final Report, 16 Nov. 1986 - 30 Sep. 1987**
Colin P. Britcher and Charles W. Alcorn Oct. 1987 54 p
(Grant NAG1-716)
(NASA-CR-181152; NAS 1.26:181152) Avail: NTIS HC A04/MF A01 CSCL 14B

The NASA Langley Research Center 13 inch Magnetic Suspension and Balance System (MSBS) is operational. However, several hardware additions and upgrades are still required in order to pursue the presently planned test program with high data quality. The planned or implemented enhancements in three areas are detailed, namely the aerodynamic and structural design of the test section leg, provision of a dummy support system, and software for data presentation. Author

**N87-29544*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**LANGLEY AIRCRAFT LANDING DYNAMICS FACILITY**
Pamela A. Davis, Sandy M. Stubbs, and John A. Tanner Oct. 1987 35 p
(NASA-RP-1189; L-16293; NAS 1.61:1189) Avail: NTIS HC A03/MF A01 CSCL 14B

The Langley Research Center has recently upgraded the Landing Loads Track (LLT) to improve the capability of low-cost testing of conventional and advanced landing gear systems. The unique feature of the Langley Aircraft Landing Dynamics Facility (ALDF) is the ability to test aircraft landing gear systems on actual runway surfaces at operational ground speeds and loading conditions. A historical overview of the original LLT is given, followed by a detailed description of the new ALDF systems and operational capabilities. Author

**N87-29545#** Little (Dallas N.) and Associates, Bryan, Tex.
**SOIL STABILIZATION FOR ROADWAYS AND AIRFIELDS Final Report, 17 Jun. 1981 - 1 Jul. 1982**
Dallas N. Little, Marshal R. Thompson, Ronald L. Terrell, Jon A. Epps, and Ernest J. Barenberg Jul. 1987 345 p
(Contract F08637-81-C-0039)
(AD-A183382; ESL-TR-86-19) Avail: NTIS HC A15/MF A01 CSCL 08J

This report provides fundamental concepts of chemical soil stabilization so that a user might evaluate soil stabilization as a pavement construction alternative, determine the type and quantity of stabilizer required and direct the construction of stabilized pavement layers. The methods covered include stabilization of roadway and airfield systems with time, cement, asphalt, fly ash and combination stabilizers. GRA

# 12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

**N87-29546** Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
**THE UNIVERSE AND MANNED SPACE FLIGHT**
Gordon N. Patterson Nov. 1986 73 p
(UTIAS-Rev-49; ISSN-0082-5247) Copyright Avail: Issuing Activity

The accelerating progress in planetary investigations and in orbital missions points to ventures in the solar system. According to the Special Theory of Relativity, the relativistic energy of the microcosm and the relativistic time of the microcosm open the way to deep space mission. The conquest of space points to new vistas for humanity, to a greater sense of freedom, to new and better opportunities, and to improve well-being for all mankind. Topics covered were: the role of metaphysical science (mathematical) science; electrogmagnetic radiation; the three basic realms of the universe; the macrocosm; manned space flight; the Lorentz transformation; the principle of relativity; relativistic conservation laws; and relativistic mass and energy. B.G.

**N87-29547#** Joint Publications Research Service, Arlington, Va.
**JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: SPACE**
19 Aug. 1987 165 p Transl. into ENGLISH from various Russian articles
(JPRS-USP-87-005) Avail: NTIS HC A08/MF A01

Numerous topics in space sciences, interplanetary sciences, space engineering, space applications, and space policy and administration are discussed. For individual titles, see N87-29548 through N87-29575.

**N87-29548#** Joint Publications Research Service, Arlington, Va.
**ANISOTROPY OF RELIC RADIATION DURING PERIOD OF SECONDARY IONIZATION OF COSMOLOGICAL HYDROGEN Abstract Only c93**
Ye. I. Dorosheva and P. D. Naselskiy *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 30 Transl. into ENGLISH from Astronomicheskiy Zhurnal (Moscow, USSR), v. 64, no. 1, Jan. - Feb. 1987 p 1-14 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

Experimental data on the small-scale angular anisotropy of relic electromagnetic radiation are an important source of information on the early universe. This approach was used in a study of the generation of small-scale anisotropy using models with secondary ionization of pregalactic matter. In the modeling it was postulated that the source of excess radiation is high-energy quanta arising during the decay of unstable massive particles or primordial black holes. The kinetics of ionization and hydrogen recombination were studied and the principle variants of change in plasma optical thickness were computed. It is demonstrated that nonequilibrium ionization of pregalactic plasma is an effective mechanism of attenuation of small-scale anisotropy of relic radiation. Author

**N87-29549#** Joint Publications Research Service, Arlington, Va.
**OUTBURST FREQUENCY AND SPATIAL DISTRIBUTION OF TYPE 1 AND TYPE 2 SUPERNOVAE Abstract Only c90**
D. Yu. Tsvetkov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 31 Transl. into ENGLISH from Astronomicheskiy Zhurnal (Moscow, USSR), v. 64, no. 1, Jan. - Feb. 1987 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

Using observational data from the supernova service (State Astronomical Observatory and Asiago Observatory) a study was made of outbursts of supernovae of types 1 and 2 in galaxies of different morphological types, including a comparison of the spatial distribution of SN 1 and SN 2 in spiral galaxies. Analysis of the data for the period of approximately 1960 to 1983 indicates an absence of significant differences in the statistical characteristics of SN 1 and SN 2. The frequencies of their outbursts are identical in most spiral galaxies. Author

**N87-29550#** Joint Publications Research Service, Arlington, Va.
**DETECTION OF CLOSE BINARY SYSTEMS BY OBSERVATIONS OF LUNAR OCCULTATIONS OF STARS USING 6-METER TELESCOPE Abstract Only c89**
G. M. Beskin, M. B. Bogdanov, S. I. Neizvestnyy, A. A. Pimonov, V. L. Plakhotnichenko, and V. F. Shvartsman *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 32 Transl. into ENGLISH from Astronomicheskiy Zhurnal (Moscow, USSR), v. 64, no. 1, Jan. - Feb. 1987 p 108-118 Original language document was announced in IAA as A87-34138 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

The results of photoelectric observations of the lunar occultation of 10 stars which were carried out with a 6-m telescope are presented. The brightness strip distribution of the occulted source is restored using a modified regularization method in which a priori information on the nonnegativity of the solution is accounted for. The upper limits to the angular diameters of eight stars are obtained. For a star with a brightness of 11.07 mag., an angular resolution of 1.0101 is achieved. SAO 128720 and SAO 110268 close binary systems were detected. Author

**N87-29551#** Joint Publications Research Service, Arlington, Va.
**METHOD FOR DETERMINING PERTURBED ORBITS OF UNKNOWN COSMIC OBJECTS FROM OPTICAL OBSERVATIONS Abstract Only c13**
N. I. Perov *In its* JPRS Report: Science and Technology. USSR:

Space 19 Aug. 1987 p 33 Transl. into ENGLISH from Astronomicheskiy Zhurnal (Moscow, USSR), v. 64, no. 1, Jan. - Feb. 1987 p 187-195 Original language document was announced in IAA as A87-34147 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

A direct method for calculating, in initial time-space, the position and velocity vectors of unidentified artificial celestial bodies in the framework of the generalized problem of two fixed centers using measurements of angular coordinates is presented. It is concluded that the elements of the preliminary orbits of artificial earth satellites determined from optical observations in models of intermediate motion are more effective than Keplerian orbital elements in calculating search ephemerides and refining the preliminary satellite orbits. Author

**N87-29552#** Joint Publications Research Service, Arlington, Va.
**ASTRONOMIC REFRACTION IN POLAR REGIONS BASED ON AEROLOGIC SOUNDINGS Abstract Only c89**
F. D. Zablotskiy and L. A. Kulish *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 34 Transl. into ENGLISH from Geodeziya i Kartografiya (Moscow, USSR), no. 1, Jan. 1987 p 17-20 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

Theoretical studies of refraction at high zenith distances were performed and magnitudes were established as a function of time of year and position of observation point in order to determine the suitability to the polar regions of the standard Soviet tables for astronomic refraction. The astronomical refraction was computed for each model atmosphere for zenith distances of 1 degree to 90 degrees. It was found that in the polar regions, particularly the central Antarctic, existing tables do not properly consider astronomic refraction for observations at great zenith distances. Author

**N87-29553#** Joint Publications Research Service, Arlington, Va.
**OPTIMIZING EXPERIMENTAL PROGRAMS IN OPERATIONAL PLANNING OF RESEARCH CARRIED OUT FROM SPACECRAFT Abstract Only**
M. Yu. Belyayev and D. N. Rulev *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 37 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 30-36 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

An integrated approach is given for optimal preparation of an experimental program for flights of orbital stations of the Salyut type. It is shown that operational planning of experiments is esentially a linear programming program. A set of programs for the BESM-6 computer was developed for use with this method. A specific example is given. Author

**N87-29554#** Joint Publications Research Service, Arlington, Va.
**SOLVING OPTIMAL ATMOSPHERIC ENTRY CONTROL PROBLEMS Abstract Only c18**
Yu. F. Golubev and R. Z. Khayrullin *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 38 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 37-46 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

A modification of the successive linearization method defined earlier by the authors (Preprint No. 157, Moscow, IPM AN SSSR, 1985) is proposed which makes it possible to carry out the iterative procedure of search for optimal control in a class of step functions and continuous piecewise-linear functions. This proposed modification is the basis for functional filling of the SAFRA set of practical programs written for the solution of a number of optimal control problms arising in atmospheric entry. These procedures are being applied with success using the BESM-6 computer. Computations of atmospheric characteristics are being made using auxiliary programs which employ formulas for quadratic and cubic interpolation between the elements and the corresponding tables. The practical programs have been used in the numerical solution of the problem of determining the attainability region and in ascertaining the range of possible final velocities for atmospheric entry trajectories leading to a stipulated point. Author

**N87-29555#** Joint Publications Research Service, Arlington, Va.
**INFLUENCE OF LARGE-SCALE SOLAR WIND DISTURBANCES ON DYNAMICS OF OUTER RADIATION BELT RELATIVISTIC ELECTRONS Abstract Only c92**
I. P. Bezrodnykh, Ye. I. Morozova, and Yu. G. Shafer *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 39 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 64-73 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

Streams of high-energy (E sub e approx. 1 MeV) electrons were measured on the Prognoz-7 and Raduga satellites to study the relationship between increases in electron intensity in the outer magnetosphere and large-scale solar wind disturbances. About 50 measurements were made of intensity increases in the outer radiation belt, revealing a dependence of electron intensity on solar wind velocity. It was found that the maximum of the stream of relativistic electrons lags by approx. 2.5 days relative to the solar wind velocity maximum. It is postulated that increases in the stream of relativistic electrons in the outer radiatin belt may be related to an intensification of the radial diffusion of electrons from the boundary of the magnetosphere, assuming that a source of high-energy electrons is situated at the boundary of the magnetosphere. The effect of high velocity solar wind streams on the geomagnetosphere involves electron acceleration near the magnetopause and an intensification of the transfer of high-energy particles into the depths of the magnetosphere. Author

**N87-29556#** Joint Publications Research Service, Arlington, Va.
**COMPARISON OF SATELLITE MEASUREMENTS OF ELECTRICAL AND MAGNETIC FIELDS AND PARTICLE STREAMS WITH SURFACE GEOPHYSICAL DATA IN EARLY MORNING SECTOR OF AURORAL ZONE Abstract Only c46**
N. V. Isayev, A. G. Yakhnin, S. V. Bilichenko, T. N. Kolosova, V. I. Lazarev, R. Pellinen, N. Petkov, T. Stanev, M. V. Teltsov, and D. Teodosiyev et al. *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 40 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 74-85 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

An analysis of Intercosmos-Bolgariya-1300 satellite data afforded a possibility for clarifying the interrelationship of different auroral structures when used in combination with surface data. The studied data were for two satellite transits near the Kola Peninsula, where several magnetometers were in operation and surface observations of radioauroras and auroras were made. These transits were of particular interest because they applied to the morning sector of the auroral zone, a sector which has been poorly studied. An analysis was made of the relationship between longitudinal currents and characteristics of injected electrons; the relationship between auroral structures, longitudinal currents and the electric field. Author

**N87-29557#** Joint Publications Research Service, Arlington, Va.
**OBSERVATIONS OF RECURRENT HIGH-VELOCITY SOLAR WIND STREAMS IN DECLINING PHASE OF SOLAR ACTIVITY CYCLE 21 USING WIDE-ANGLE ION ENERGY SPECTROMETER ABOARD PROGNOZ-9 SATELLITE Abstract Only c92**
K. I. Gringauz, V. V. Bezrukikh, M. N. Verigin, and G. A. Kotova *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 41 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 86-92 Original language document was announced in IAA as A87-34214 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

Solar wind measurements made on the Prognox-9 satellite during the period from July 1983 to February 1984 in the declining phase of solar cycle 21 afforded a possibility for checking the reliability of conclusions concerning long-period variations of solar wind properties drawn on the basis of earlier experiments. Measurements of the plasma ion component were made by the modulation method using the D-137A ion energy spectrometer. The velocity of some of the solar wind streams attained 700 to 800 km/s. The data demonstrate the renewal of the regular structure of high velocity streams in the solar wind in the declining phase, as predicted earlier on the basis of solar wind measurements in the preceding cycle, indicating that the presence of recurrent high-velocity streams in the declining phases of the 11-year solar cycles is a regular feature of such cycles. Author

**N87-29558#** Joint Publications Research Service, Arlington, Va.
**DEPENDENCE OF SOLAR WIND VELOCITY ON DISTANCE TO HELIOSPHERIC CURRENT SHEET ACCORDING TO PROGNOZ-9 SATELLITE DATA Abstract Only** **c92**
G. A. Kotova, K. I. Gringauz, V. V. Bezrukikh, M. I. Verigin, L. A. Shvachunova, W. Riedler, and K. Shvingenshu *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 42 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 93-102 Original language document was announced in IAA as A87-34215 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

The relationship between the large-scale structure of recurrent high-speed solar wind streams (as observed by Prognoz-9 during 1983 and 1984) and the large-scale structure of the heliospheric current sheet (HCS) is investigated. The dependence of the solar wind velocity V on the angular distance lambda to the HCS is analyzed. Based on the Prognoz-9 measurements, the V (lambda) relationship is approximated as V (km/s) equals 410 plus 305 sin squared lambda. Author

**N87-29559#** Joint Publications Research Service, Arlington, Va.
**OBSERVATIONS OF IONOSPHERIC TROUGH AT GREAT ALTITUDES USING PROGNOZ-5 SATELLITE Abstract Only** **c46**
V. P. Grigoryeva and V. V. Pisareva *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 43 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 103-109 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

The results of observations of the ionospheric trough at altitudes of 1000 to 6000 m using the Prognoz-5 satellite, which intersected the auroral gap in the southern hemisphere are given. The observations were made during a period close to the solar activity minimum. Apogee was in the northern hemisphere at a geocentric distance of 200,000 km and perigee was in the southern hemisphere. During these observations, perigee altitude varied from 1100 to 3000 km. Radio emission from the satellite was received in the frequency range 50 to 1000 kHz and registered using a cosmic radio emission analyzer at 10 discrete frequencies. Author

**N87-29560#** Joint Publications Research Service, Arlington, Va.
**MEASUREMENTS OF IONOSPHERIC ELECTRON TEMPERATURE USING LOW-FREQUENCY IMPEDANCE METER Abstract Only** **c46**
V. I. Aksenov, A. P. Modestov, and L. Yu. Sokolov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 44 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 110-117 Original language document was announced in IAA as A87-34217 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

Two techniques for measuring ionospheric electron temperature are proposed which are based on low-frequency impedance measurements of a satellite-borne rod antenna. One technique uses the dependence of the antenna conductance on the electromagnetic force induced in the antenna as it moves in the geomagnetic field; the other technique uses the nonlinear dependence of the conductance on the amplitude of LF voltage on the antenna. An error analysis is carried out, and attention is given to results of midlatitude measurements made with the Intercosmos- Copernicus-500 satellite at the autumnal equinox during the solar minimum period. Author

**N87-29561#** Joint Publications Research Service, Arlington, Va.
**DETERMINING INTERVALS AND DATES OF ONSET OF CRITICAL ILLUMINATION CONDITIONS FOR SPACECRAFT INSTRUMENTS Abstract Only** **c74**
I. D. Ibragimov and B. S. Shrebushevskiy *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 46 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 141-147 Original language document was announced in IAA as A87-34221 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

Problems involving the determination of the time intervals and dates of critical solar illumination conditions for the operation of spacecraft instruments are examined. The solution to these problems is based on methods employing the transformation of vector conditions of critical illumination to trigonometric inequalities. Cases of elliptical, circular, and stationary satellite orbits are considered. Author

**N87-29562#** Joint Publications Research Service, Arlington, Va.
**RESONANCE PHENOMENA ACCOMPANYING EVOLUTION OF TRANSLATIONAL-ROTATIONAL MOTION OF VISCOELASTIC PLANET Abstract Only** **c91**
V. G. Vilke and K. M. Lebedev *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 47 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 148-152 Original language document was announced in IAA as A87-34222 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

Resonance phenomena in the translational-rotational motion of a viscoelastic planet are investigated theoretically on the basis of equations of motion derived by Vil'ke (1984). It is shown that, in the presence of resonances, the evolution rate of the rotational motion of the planet can be sharply reduced; i.e., the planet will remain for a sufficiently long time in the state of resonance rotation. However, the orbital evolution continues to proceed, and the system ultimately leaves the resonance regime. Author

**N87-29563#** Joint Publications Research Service, Arlington, Va.
**SINGLE-IMPULSE TRANSFER FROM ARTIFICAL EARTH SATELLITE ORBIT TO CONDITIONALLY PERIODIC TRAJECTORY AROUND COLLINEAR LIBRATION POINT OF SUN-EARTH SYSTEM Abstract Only** **c13**
M. N. Boyarskiy and A. I. Sheykhet *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 48 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 152-154 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

A class of trajectories for putting a spacecraft into a conditionally periodic trajectory about collinear libration points of the Sun-Earth system with use of a single impulse for departure from an artificial Earth satellite orbit was studied. A special coordinate system was introduced for solving the formulated problem and various initial conditions were tested. The numerical analysis revealed that with an appropriate choice of initial parameters it is feasible to make a single impulse transfer from an artificial Earth satellite orbit into a conditionally periodic trajectory about a collinear libration point with an adequately long lifetime (six or more months, depending on initial conditions). Author

**N87-29564#** Joint Publications Research Service, Arlington, Va.
**BACKGROUND CONDITIONS FOR OBSERVING RADIO EMISSION OF ULTRAHIGH-ENERGY RADIO EMISSION PARTICLES Abstract Only** **c93**
A. T. Abrosimov, Z. Klos, S. B. Lyakhov, G. G. Managadze, Yu. V. Mineyev, W. K. Riedler, and M. F. Fridrikh *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 49 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 155-157 Original language document was announced in IAA as A87-34224 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

An experiment was carried out to determine the background conditions in near-Earth space for radio emission observations of primary cosmic rays at energies exceeding 10 to the 19th eV. Extensive air showers were observed during the G60S experiment with the Vertikal rocket. Measurements were made at heights above the ionosphere and for frequencies of radiation not reflected by the ionosphere. Averaged emission spectra for various heights from 108 to 1500 km are presented. Measurement results given are for the 20 to 80 MHz frequency range. Author

**N87-29565#** Joint Publications Research Service, Arlington, Va.
**ELECTRON KINETICS IN IONOSPHERIC D REGION UNDER CONDITIONS OF SIMULTANEOUS INCREASE IN IONIZATION LEVEL AND ELECTRON GAS TEMPERATURE Abstract Only** **c46**
S. I. Kozlov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 50 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 157-158 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

A universal multicomponent aeronomic model which made possible a qualitative analysis of D-region behavior under a wide range of conditions is here used in a study of the kinetics of electrons at 60 less than or equal to h less than or equal to 80 km when there is a simultaneous increase in the ionization level and electron gas temperature T sub e. The universal model, since it provides for the possibility of broad variation of input parameters and the use of a complete scheme of microcomputers and the dependence of their rate constants on T sub e and temperature T of the neutral gas, also made it possible to solve the formulated problem of D-region behavior when there is a simultaneous increase in the ionization level and electron gas temperature. Author

**N87-29566#** Joint Publications Research Service, Arlington, Va.
**EXPERIMENT PROGRAM OF PROJECT PHOBOS**
T. K. Breus *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 54-70 Transl. into ENGLISH from Sovremennyye Dostizheniya Kosmonavtiki (Novoye v Zhizni, Nauke Tekhnike: Seriya Kosmonavtika, Astronomiya) (Moscow, USSR), no. 12, Dec. 1986 p 44-64 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

A flight program that will make a high-resolution television survey of the surface of Mars is discussed. Radiometric and photometric measurements will be used to produce a temperature map of the surface of Mars, study the diurnal and seasonal dynamics of temperature conditions, measure the thermal inertia of the soil, and search for permafrost regions. Investigations of Phobos and the Sun are also described. R.J.F.

**N87-29567#** Joint Publications Research Service, Arlington, Va.
**COMMENTARY ON PHOBOS MISSION EXPERIMENTS**
Yu. Gordeyev *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 71-75 Transl. into ENGLISH from Moskovskaya Pravda (Moscow, USSR), 5 Nov. 1986 p 3 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

The Phobos mission experiments that will study Mars, Phobos and the Sun are discussed. The 460 day mission is planned for a July 1988 launch. A video survey of Mars surface, as well as infrared and gamma ray surveys to study the thermophysical and reflective properties of the planets surface will be performed. Mars' atmosphere will be studied in joint Soviet and French experiments. The study of Phobos calls for the approach of the spacecraft to within several dozen meters of the surface. The spacecraft will practically hover over the surface of the Martian satellite. The rate of motion will not exceed 2 meters per second. At this time, a video survey of Phobos is planned. A study of the structure of the Sun's chromosphere and corona is also planned. R.J.F.

**N87-29568#** Joint Publications Research Service, Arlington, Va.
**CATALOGUE OF CRATERS IN VENUSIAN NORTHERN HEMISPHERE BEARING EVIDENCE OF IMPACT ORIGIN Abstract Only** **c91**
I. M. Chernaya, V. P. Kryuchkov, A. T. Bazilevskiy, G. A. Burba, O. N. Rzhiga, G. M. Petrov, A. I. Sidorenko, and Yu. P. Aleksandrov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 75 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 21, no. 1, Jan. - Mar. 1987 p 26-36 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

A table was prepared listing 146 impact craters on Venus. The tabulation is limited to those features that are well-expressed in the relief with a diameter greater than or equal to 8 km in the survey zone to the north of 30 to 35 degrees north latitude. The tabulated data include the number of the crater, its name, coordinates, type of surrounding terrain, crater diameter, morphological type and class, the spacecraft from which it was observed, and the zone from which the image fragment was obtained. Author

**N87-29569#** Joint Publications Research Service, Arlington, Va.
**COMPUTING GAMMA QUANTA FLUX DENSITIES OVER VENUSIAN AND EARTH'S SURFACES Abstract Only** **c91**
Yu. A. Surkov and O. S. Manvelyan *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 76 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 21, no. 1, Jan. - Mar. 1987 p 37-46 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

The dependence of the density flux of unscattered gamma quanta on height above the surfaces of Venus and Earth were computed. The areas from which a definite percentage of gamma quanta were collected were computed for each height. These and other results made it possible to evaluate the optimal conditions for measuring gamma fields over the surface of the two planets. Such data are also needed for determining the elemental composition of rocks from the registered spectrum of characteristic gamma radiation. Author

**N87-29570#** Joint Publications Research Service, Arlington, Va.
**INFLUENCE OF EXTENDED NEUTRAL ATMOSPHERE ON INTERACTION BETWEEN SOLAR WIND AND NONMAGNETIC SOLAR SYSTEM BODIES. 1: VENUS** **c92**
T. K. Breus, A. M. Krymskiy, and V. Ya. Mitnitskiy *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 77 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 124-132 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

The flow of the solar wind around Venus was modelled numerically, taking into account the loading of the flow by heavy ions forming during photoionization of the neutral oxygen corona of that planet. It is shown that this effect can explain a number of aspects of interaction between the solar wind and the planet which until now have not been clear, such as the position of the bow shock, characteristics of the solar wind flow and the magnetic field behind the front. Author

**N87-29571#** Joint Publications Research Service, Arlington, Va.
**THERMAL AND PHOTOMETRIC MODEL OF COMETARY NUCLEUS Abstract Only** **c90**

M. Ya. Marov, A. V. Kolesnichenko, and Yu. V. Skorov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 78 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 21, no. 1, Jan. - Mar. 1987 p 47-60 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

A model of the physical processes transpiring in a cometary nucleus and the circumnucleus region was devised. In the model it is assumed that an atmosphere consisting of a mixture of gas and fine dust particles, which are transported from the nucleus by the gas flow, is formed at small heliocentric distances during disintegration of the cometary nucleus as a result of heating by solar radiation and sublimation of its volatile components. In the first stage of the work, the temperature distribution in the nucleus was found using a quite complete thermal model of a spherically symmetric nucleus. In the second stage, a photometric model of the gas-dust cometary atmosphere in the circumnucleus region was computed by numerical solution of the radiation transfer equation in the optical wavelength range. A photometric model of the gas-dust atmosphere was computed. Author

**N87-29572#** Joint Publications Research Service, Arlington, Va.
**REFINEMENT OF COORDINATES OF HALLEY'S COMET WITH ALLOWANCE FOR DISPLACEMENT OF OPTICAL CENTER RELATIVE TO COMETARY CENTER OF MASS Abstract Only** **c90**
V. V. Savchenko *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 79 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 21, no. 1, Jan. - Mar. 1987 p 61-64 Original language document was announced in IAA as A87-42945 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

A method is developed for taking into account the deviation of the optical center of Comet Halley from its mass center, and a comparison is made with comet positions determined by TV observations from the Vega probe. Results show that the proposed method improves the accuracy of comet position determination by almost an order of magnitude. The comet positions can be determined with an error not exceeding 100 km. Author

**N87-29573#** Joint Publications Research Service, Arlington, Va.
**MAJOR MORPHOLOGIC FEATURES OF THE ATLANTIC OCEAN SURFACE Abstract Only** **c48**
R. Kh. Greku *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 99 Transl. into ENGLISH from Issledovaniye Zemli iz Kosmosa (Moscow, USSR), no. 1, Jan. - Feb. 1987 p 20-25 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

Satellite altimetry was used to produce new information on the topography of the surface of the Atlantic Ocean. Surface topography anomalies result both from heterogeneities in the geological structure of the Earth and from hydrodynamic phenomena in the ocean. Large scale features of the Atlantic Ocean surface are discussed. These features are compared with known geomorphologic features of the bottom relief. Author

**N87-29574#** Joint Publications Research Service, Arlington, Va.
**GEOMAGNETIC INTERSECTION OF TECTONIC STRUCTURES SEEN IN SPACE PHOTOGRAPHS Abstract Only** **c46**
M. I. Burleshin *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 111 Transl. into ENGLISH from Issledovaniye Zemli iz Kosmosa (Moscow, USSR), no. 6, Nov. - Dec. 1986 p 32-37 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

Interpretation of space photographs yields information on positive tectonic structures in platform territories. Analysis of previous works indicates that positive tectonic structures of widely varied configurations are found by different authors in the same territory. An attempt is made here to analyze the reasons for this variety and to characterize the major types of intersections of tectonic structures. Recommendations are given for increasing the effectiveness of utilization of space photographs in geological structure studies. Author

**N87-29575#** Joint Publications Research Service, Arlington, Va.
**ANALYSIS OF DIRECTIONS OF LINEAR IMAGE ELEMENTS BY STRUCTURE-ZONAL METHOD Abstract Only** **c43**
V. A. Kottsov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 118 Transl. into ENGLISH from Issledovaniye Zemli iz Kosmosa (Moscow, USSR), no. 6, Nov. - Dec. 1986 p 97-100 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

The method of structure-zone transformation of video information is one possible means of increasing the effectiveness of studying the Earth from space. The essence of the method is analysis of the characteristics of the spatial structure of an object onboard the spacecraft, with formation of images which code changes in structural characteristics over the field of vision. Here, the specifics of one particular case, structural analysis of the directions of linear elements, as in analysis of the directions of a wide wave action on water surfaces, are studied. Author

**N87-29576*** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**TECHNOLOGY FOR LARGE SPACE SYSTEMS. A BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 17)**
Oct. 1987 140 p
(NASA-SP-7046(17); NAS 1.21:7046(17)) Avail: NTIS HC A07 CSCL 22B

This bibliography lists 512 reports, articles, and other documents introduced into the NASA scientific and technical information system between January 1, 1987 and June 30, 1987. Its purpose is to provide helpful information to the researcher, manager, and designer in technology development and mission design according to system, interactive analysis and design, structural and thermal analysis and design, structural concepts and control systems, electronics, advanced materials, assembly concepts, propulsion, and solar power satellite systems. Author

**N87-29577*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**AEROTHERMODYNAMICS RESEARCH AT NASA AMES RESEARCH CENTER**
George S. Deiwert Sep. 1987 39 p Submitted for publication
(NASA-TM-89439; A-87149; NAS 1.15:89439) Avail: NTIS HC A03/MF A01 CSCL 22A

Research activity in the aerothermodynamics branch at the NASA Ames Research Center is reviewed. Advanced concepts and mission studies relating to the next generation aerospace transportation systems are summarized and directions for continued research identified. Theoretical and computational studies directed at determining flow fields and radiative and convective heating loads in real gases are described. Included are Navier-Stokes codes for equilibrium and thermochemical nonequilibrium air. Experimental studies in the 3.5-ft hypersonic wind tunnel, the ballistic ranges, and the electric arc driven shock tube are described. Tested configurations include generic hypersonic aerospace plane configurations, aeroassisted orbital transfer vehicle shapes and Galileo probe models. Author

**N87-29916*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**LEO AND GEO MISSIONS**
Enrico Mercanti *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 9-14 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 22A

# 13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

**N87-29551#** Joint Publications Research Service, Arlington, Va.
**METHOD FOR DETERMINING PERTURBED ORBITS OF UNKNOWN COSMIC OBJECTS FROM OPTICAL OBSERVATIONS Abstract Only**
N. I. Perov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 33 Transl. into ENGLISH from Astronomicheskiy Zhurnal (Moscow, USSR), v. 64, no. 1, Jan. - Feb. 1987 p 187-195 Original language document was announced in IAA as A87-34147 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29563#** Joint Publications Research Service, Arlington, Va.
**SINGLE-IMPULSE TRANSFER FROM ARTIFICAL EARTH SATELLITE ORBIT TO CONDITIONALLY PERIODIC TRAJECTORY AROUND COLLINEAR LIBRATION POINT OF SUN-EARTH SYSTEM Abstract Only**
M. N. Boyarskiy and A. I. Sheykhet *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 48 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 152-154 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

# 14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

No abstracts in this category.

# 15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

**N87-29578*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**COSPAS-SARSAT SATELLITE ORBIT PREDICTOR. VOLUME 10: ALMANAC, 16 OCTOBER 1987 - 15 APRIL 1988 Report, Apr. - Oct. 1987**
Morton L. Friedman Oct. 1987 107 p
(NASA-TM-85015-Vol-10; Rept-87B0289-Vol-10; NAS 1.15:85015-Vol-10) Avail: NTIS HC A06/MF A01 CSCL 22B

The satellite orbit predictor is a graphical aid for determining the relationship between the satellite (COSPAS or SARSAT) orbit, antenna coverage of the spacecraft and coverage of the local user terminals (LUT). The predictor allows the user to quickly visualize if a selected position will probably be detected and is composed of a base map and a satellite track overlay for each satellite. Additionally, a table of equator crossings for each satellite is included. M.G.

**N87-29579#** Scientific Systems, Inc., Cambridge, Mass.
**NONLINEAR CONTROL THEORY FOR MISSILE AUTOPILOT DESIGN Final Technical Report, 15 Aug. 1986 - 14 Feb. 1987**
Donald E. Gustafson, John Baillieul, and Mark Levi 24 Apr. 1987 68 p
(Contract F49620-86-C-0101)
(AD-A183062; AFOSR-87-0918TR) Avail: NTIS HC A04/MF A01 CSCL 16B

Bank-to-turn steering is attractive in terms of potential performance improvements over skid-to-turn steering. In order to fully realize this performance, attitude maneuvers in response to guidance system commands will sometimes take place at high body rates and angle-of-attack, where the dynamics are nonlinear. The problem is further complicated by constraints on angle of attack, control surface deflections and body rates. It appears that linear control methods may be inadequate in these cases. In this paper we consider several nonlinear control approaches. A decoupling controller is derived and shown to be well-defined (nonsingular). Conditions for constraint avoidance are derived. Stability is analyzed in the presence of estimation errors. A minimum-time control law which takes constraints into account is derived, resulting in a bang-bang controller. GRA

**N87-29580#** Northeastern Univ., Boston, Mass. Electronics Research Lab.
**INSTRUMENTATION AND COMMUNICATION SYSTEMS FOR SOUNDING ROCKETS AND SHUTTLE-BORNE EXPERIMENTS Final Report, 4 Dec. 1982 - 31 Dec. 1986**
J. S. Rochefort, Lawrence J. OConnor, Raimundas Sukys, Norman C. Poirier, and Thomas P. Wheeler 27 Apr. 1987 138 p
(Contract F19628-83-C-0037)
(AD-A183541; AFGL-TR-87-0139) Avail: NTIS HC A07/MF A01 CSCL 22B

This report deals with analysis, development and field support of instrumentation and telemetry systems for airborne vehicles. The BERT, ERNIE, EXCEDE and BEAR programs discussed require instrumentation and telemetry which operate under the adverse EMI environments created by electron guns, ion sources or particle beams. The PIIE and POLAR ARC vehicles described low-modulation-index FM/FM systems. Signal processing, data formatting, encoding, tape recorders and packet telemetry are described for future shuttle flights under the GAS, VIPER and IMPS programs. Author (GRA)

**N87-29581*#** Rohr Industries, Inc., Chula Vista, Calif.
**FABRICATION OF PREPACKAGED SUPERALLOY HONEYCOMB THERMAL PROTECTION SYSTEM (TPS) PANELS Interim Report**
W. Blair, J. E. Meaney, and H. A. Rosenthal Washington NASA Oct. 1985 192 p
(Contract NAS1-15646)
(NASA-CR-3755; NAS 1.26:3755) Avail: NTIS HC A09/MF A01 CSCL 11D

High temperature materials were surveyed, and Inconel 617 and titanium were selected for application to a honeycomb TPS configuration designed to withstand 2000 F. The configuration was analyzed both thermally and structurally. Component and full-sized panels were fabricated and tested to obtain data for comparison with analysis. Results verified the panel design. Twenty five panels were delivered to NASA Langley Research Center for additional evaluation. Author

**N87-29482#** Rheinmetall G.m.b.H., Duesseldorf (West Germany). Guided Munition Dept.
**JET REACTION CONTROL SYSTEM FOR AUTONOMOUS PRECISION MUNITION**
H. Peller and S. Buechele-Buecher *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 18 p Original contains color illustrations (For primary document see N87-29474 24-04)
Copyright Avail: NTIS HC A07/MF A01

**N87-29483#** Naval Surface Weapons Center, Dahlgren, Va. Weapons Systems Dept.
**APPLICATION OF OPTIMAL ESTIMATION AND CONTROL CONCEPTS TO A BANK-TO-TURN MISSILE**

E. J. Ohlmeyer *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 12 p (For primary document see N87-29474 24-04)
Copyright Avail: NTIS HC A07/MF A01

# 16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

**N87-29582*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**EARTH-TO-ORBIT VEHICLE PROVIDING A REUSABLE ORBITAL STAGE AND METHOD OF UTILIZING SAME Patent Application**
James A. Martin, inventor (to NASA) 23 Jul. 1987 15 p
(NASA-Case-LAR-13486-1; NAS 1.71:LAR-13486-1; US-Patent-Appl-SN-076955) Avail: NTIS HC A02/MF A01 CSCL 22B

A reusable Earth-to-orbit vehicle is described with an orbital stage sized to fit into a payload bay equipped, Earth-return-capable space vehicle such as the United States Space Shuttle. The orbital stage is equipped with a reusable rocket engine capable of operation from the Earth's surface to Earth orbit. The orbital stage propels itself into Earth orbit with the help of boosters that separate and return to Earth before orbit is reached. After delivering its payload, the orbital stage is placed in the Earth-return-capable space vehicle's payload bay and returned to Earth for reuse.
NASA

**N87-29583#** Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
**DESIGN OF A MIXED FLEET TRANSPORTATION SYSTEM TO LOW EARTH ORBIT. VOLUME 1: EXECUTIVE SUMMARY. VOLUME 2: NEAR-TERM SHUTTLE REPLACEMENT. VOLUME 3: HEAVY-LIFT CARGO VEHICLE. VOLUME 4: ADVANCED TECHNOLOGY SHUTTLE REPLACEMENT**
Susan T. Fields, Kevin D. Johnson, Thomas S. Nichols, Michael J. Novin, Paul J. Shawcross, Barton E. Showalter, Eli Niewood, comp., Chris Young, comp., and Chris Peterson, ed. and comp. 1987 852 p
Avail: NTIS HC A99/MF E03

The future of the American space program will depend on the development and choice of the next generation of launch vehicles. Future payloads may be too massive for the current Space Transportation System. Other missions may require the transportation of large crews of humans to the space station. Consequently, future launch vehicle fleets need to emphasize diversity and low cost. The design of four vehicles chosen to fulfill the future payload delivery requirements is discussed in general terms. An analysis of the cost and design of these vehicles will follow. This analysis will lead to a complete annual schedule of payload deliveries. Two different delivery programs are proposed: one strives for the lowest possible cost, and the other emphasizes the advancement of high technology in the space program.
Author

# 17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

**N87-29584*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**PERFORMANCE CHARACTERISTICS OF OMNIDIRECTIONAL ANTENNAS FOR SPACECRAFT USING NASA NETWORKS**
Lawrence M. Hilliard Jul. 1987 31 p
(NASA-TM-100680; Rept-87F0005; NAS 1.15:100680) Avail: NTIS HC A03/MF A01 CSCL 20N

Described are the performance capabilities and critical elements of the shaped omni antenna developed for NASA for space users of NASA networks. The shaped omni is designed to be operated in tandem for virtually omnidirectional coverage and uniform gain free of spacecraft interference. These antennas are ideal for low gain data requirements and emergency backup, deployment, amd retrieval of higher gain RF systems. Other omnidirectional antennas that have flown in space are described in the final section. A performance summary for the shaped omni is in the Appendix. This document introduces organizations and projects to the shaped omni applications for NASA's space use. Coverage, gain, weight, power, and implementation and other performance information for satisfying a wide range of data requirements are included.
Author

# 18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

**N87-29585*#** Ball Aerospace Systems Div., Boulder, Colo.
**PHASE 3 STUDY OF SELECTED TETHER APPLICATIONS IN SPACE. VOLUME 1: EXECUTIVE SUMMARY Final Report**
Dec. 1986 33 p
(Contract NAS8-36617)
(NASA-CR-179185; NAS 1.26:179185; DPD-665-Vol-1; DR-4-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 22B

A tethered launch assist from the Shuttle for payloads with up to 10,000 kg mass for the mission model and the tethering of a 15,000 kg science platform for the space station were addressed. Also encompassed was the design and cost analysis for a variable g device that could be placed on the tether and allow ultralow g or other types of experiments to be conducted. Numerous tether applications were examined and their theoretical feasibility and technology requirements were assessed.
B.G.

**N87-29586*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**SPACE VEHICLE THERMAL REJECTION SYSTEM Patent Application**
Herbert J. Tanzer, inventor (to NASA) (Hughes Aircraft Co., Culver City, Calif.) 15 Jul. 1987 16 p
(NASA-Case-LAR-13738-1; NAS 1.71:LAR-13738-1; US-Patent-Appl-SN-073539) Avail: NTIS HC A02/MF A01 CSCL 22B

A space vehicle thermal heat rejection system utilizes separate optimized heat pipe components for the functions of heat acquisition, heat transport, and heat rejection. A honeycomb panel heat pipe evaporator section performs the function of heat acquisition, and forms a closed thermodynamic system with a dual channel heat pipe transport section, which performs the function

of heat transport. A plurality of truss or channel core heat pipe rejection fins form the condensor section, which performs the function of heat rejection. A common wall separates the condensor section from the transport section. Using the above heat pipe components and having efficient interfacing between them results in high performance factors for the overall system. NASA

**N87-29587#** Sandia National Labs., Albuquerque, N. Mex.
**MAXIMUM TERMINAL VELOCITY TURNS AT CONSTANT ALTITUDE**
G. R. Eisler and D. G. Hull 1987 21 p Presented at the AIAA Aerodynamics Flight Mechanics Conference, Monterey, Calif., 17 Aug. 1987 Prepared in cooperation with Texas Univ., Austin
(Contract DE-AC04-76DP-00789)
(DE87-005061; SAND-87-0031C; CONF-870830-5) Avail: NTIS HC A02/MF A01

An optimal control problem is formulated for a maneuvering reentry vehicle to execute a maximum terminal velocity turn at constant altitude to a fixed final position. A control solution technique is devised which uses a Newton scheme to repetitively solve a nonlinear algebraic system for two parameters to provide the on-line guidance. The turn control takes advantage of the high dynamic pressure at the beginning of the flight path; the lift solution acts to null deviations from the prescribed altitude. Control solutions are compared for a continuously updated, approximate physical model, for a simulation of the approximate optimal guidance in a true physical model, and for a parameter optimization solution for the true model. End constraint satisfaction is excellent. Overall trajectory agreement is good, if the assumed atmospheric model is reasonably accurate. DOE

**N87-29588#** Sandia National Labs., Albuquerque, N. Mex.
**AN AERODYNAMIC MODEL FOR A HEMISPHERICALLY-CAPPED BICONIC REENTRY VEHICLE WITH SIX DRAG FLAPS**
T. M. Jordan and R. J. Buffington 1987 15 p Presented at the AIAA Aerodynamics Flight Mechanics Conference, Monterey, Calif., 17 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-010476; SAND-87-0063C; CONF-870830-6) Avail: NTIS HC A02

The development of an aerodynamic model for a hemispherically-capped biconic reentry vehicle with six drag flaps is presented. The aerodynamic model is primarily based on wind tunnel test results, with the use of computational fluid dynamic codes. For Mach numbers from 4 to 15, the inviscid axial force coefficient was computed for drag flap deflections from 6 to 36 degs. Axial force coefficient was found to vary significantly with ablating flap shape as well as with changing flight conditions. The aerodynamic model can be used for input to vehicle recovery trajectory simulations. DOE

**N87-29589#** Lawrence Livermore National Lab., Calif.
**MaRV (MANEUVERABLE REENTRY VEHICLES) PoP (PROBABILITY OF PENETRATION) VERSUS CEP (CIRCULAR ERROR PROBABILITY) ANALYSIS CONCEPT STUDY (MaRV PENETRATION STUDY PROJECT**
J. M. Morris 1 Aug. 1986 20 p
(Contract W-7405-eng-48)
(DE87-011903; UCID-20919) Avail: NTIS HC A02/MF A01

The performance analysis of maneuverable reentry vehicles (MaRV) in terms of its probability of penetration (PoP) against terminal engagement with a ballistic missile defense (BMD) system and in terms of its associate circular error probability (CEP), at impact is a very complex problem. A thorough study of this problem under the MaRV Penetration Study Project will require the development of a number of analytical and simulation tools. As a result of a preliminary study, a MaRV PoP vs CEP analysis concept has been formulated to support the MaRV Penetration Study Project. The concept is based on analytical models and techniques and, moreover, exploits the existing knowledge base and is physically intuitive. The analysis concept, as formulated, is applicable to arbitrary MaRV's and BMD systems. DOE

**N87-29590*#** Columbia Univ., New York, N.Y. Dept. of Civil Engineering and Engineering Mechanics.
**VIBRATIONS AND STRUCTUREBORNE NOISE IN SPACE STATION Final Report**
R. Vaicaitis, C. S. Lyrintzis, and D. A. Bofilios 9 Oct. 1987 152 p
(Grant NAG1-541)
(NASA-CR-181381; NAS 1.26:181381) Avail: NTIS HC A08/MF A01 CSCL 22B

Analytical models were developed to predict vibrations and structureborne noise generation of cylindrical and rectangular acoustic enclosures. These models are then used to determine structural vibration levels and interior noise to random point input forces. The guidelines developed could provide preliminary information on acoustical and vibrational environments in space station habitability modules under orbital operations. The structural models include single wall monocoque shell, double wall shell, stiffened orthotropic shell, descretely stiffened flat panels, and a coupled system composed of a cantilever beam structure and a stiffened sidewall. Aluminum and fiber reinforced composite materials are considered for single and double wall shells. The end caps of the cylindrical enclosures are modeled either as single or double wall circular plates. Sound generation in the interior space is calculated by coupling the structural vibrations to the acoustic field in the enclosure. Modal methods and transfer matrix techniques are used to obtain structural vibrations. Parametric studies are performed to determine the sensitivity of interior noise environment to changes in input, geometric and structural conditions. Author

**N87-29591*#** Smithsonian Astrophysical Observatory, Cambridge, Mass.
**INVESTIGATION OF PLASMA CONTACTORS FOR USE WITH ORBITING WIRES Final Report, 1 Jan. 1986 - 30 Jun. 1987**
Robert D. Estes, Mario D. Grossi, and Robert Hohlfeld Sep. 1987 108 p
(Grant NAG9-126)
(NASA-CR-181422; NAS 1.26:181422) Avail: NTIS HC A06/MF A01 CSCL 22B

The proposed Shuttle-based short tether experiments with hollow cathodes have the potential for providing important data that will not be obtained in long tether experiments. A critical property for hollow cathode effectiveness as a plasma contactor is the cross magnetic field conductivity of the emitted plasma. The different effects of hollow cathode cloud overlap in the cases of motion-driven and battery-driven operation are emphasized. The calculations presented on the size and shape of the hollow cathode cloud improve the qualitative picture of hollow cathodes in low Earth orbit and provide estimates of time constants for establishing the fully-expanded cloud. The magnetic boundary value problem calculations indicate the way in which the magnetic field will effect the shape of the cloud by resisting expansion in the direction perpendicular to the field. The large-scale interactions of the system were also considered. It was concluded that recent plasma chamber experiments by Stenzel and Urrutia do not model an electrodynamic tether well enough to apply the results to tethered system behavior. Orbiting short tether experiments on hollow cathodes will provide critical information on hollow cathode performance and the underlying physics that cannot be obtained any other way. Experiments should be conducted as soon as funding and a suitable space vehicle are available. B.G.

**N87-29554#** Joint Publications Research Service, Arlington, Va.
**SOLVING OPTIMAL ATMOSPHERIC ENTRY CONTROL PROBLEMS Abstract Only**
Yu. F. Golubev and R. Z. Khayrullin *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 38 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 37-46 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29864*#** RCA Aerospace and Defense, East Windsor, N.J. Astro-Space Div.
**DEVELOPMENT OF A STANDARD CONNECTOR FOR ORBITAL REPLACEMENT UNITS FOR SERVICEABLE SPACECRAFT**
Ellen F. Heath, Matthew A. Braccio, Steven D. Raymus, and David W. Gross *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 81-92 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 22B

**N87-29874*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**A MULTIPURPOSE SATELLITE EJECTION SYSTEM**
Michael B. Moore *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 227-234 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 22B

**N87-29877*#** Rockwell International Corp., Downey, Calif. Space Station Systems Div.
**SPACE STATION BASED OPTIONS FOR ORBITER DOCKING/BERTHING**
Daniel J. Hoover *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 261-273 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 22B

**N87-29878*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**AN ELECTROMECHANICAL ATTENUATOR/ACTUATOR FOR SPACE STATION DOCKING**
LeBarian Stokes, Dean Glenn, and Monty B. Carroll (Lockheed Engineering and Management Services Co., Inc., Houston, Tex.) *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 275-284 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 22B

**N87-29879*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**SPACE STATION LUBRICATION CONSIDERATIONS**
Lubert J. Leger and Keith Dufrane (Battelle Columbus Labs., Ohio.) *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 285-294 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 22B

**N87-29915*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**STATUS OF SPACE STATION POWER SYSTEM**
Cosmo R. Baraona and Dean W. Sheibley *In its* Space Electrochemical Research and Technology (SERT) Sep. 1987 p 1-8 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 22B

# 19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

**N87-29592*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**NOISELESS CODING FOR THE MAGNETOMETER**
Robert F. Rice and Jun-Ji Lee 15 Jun. 1987 36 p
(Contract NAS7-918)
(NASA-CR-181325; JPL-Publ-87-19; NAS 1.26:181325) Avail: NTIS HC A03/MF A01 CSCL 22B

Future unmanned space missions will continue to seek a full understanding of magnetic fields throughout the solar system. Severely constrained data rates during certain portions of these missions could limit the possible science return. This publication investigates the application of universal noiseless coding techniques to more efficiently represent magnetometer data without any loss in data integrity. Performance results indicated that compression factors of 2:1 to 6:1 can be expected. Feasibility for general deep space application was demonstrated by implementing a microprocessor breadboard coder/decoder using the Intel 8086 processor. The Comet Rendezvous Asteroid Flyby mission will incorporate these techniques in a buffer feedback, rate-controlled configuration. The characteristics of this system are discussed.
Author

**N87-29593*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**SPACE STATION END EFFECTOR STRATEGY STUDY**
Stephen J. Katzberg, Robert L. Jensen, Kelli F. Willshire, and Robert E. Satterthwaite Aug. 1987 91 p
(NASA-TM-100488; NAS 1.15:100488) Avail: NTIS HC A05/MF A01 CSCL 22B

The results of a study are presented for terminology definition, identification of functional requirements, technolgy assessment, and proposed end effector development strategies for the Space Station Program. The study is composed of a survey of available or under-developed end effector technology, identification of requirements from baselined Space Station documents, a comparative assessment of the match between technology and requirements, and recommended strategies for end effector development for the Space Station Program. Author

# 20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

**N87-29594*#** Boeing Aerospace Co., Kent, Wash. Flight Technology Group.
**SPACE STATION PROPULSION-ECLSS INTERACTION STUDY Final Report**
Scott M. Brennan 14 Feb. 1986 92 p
(Contract NAS3-23353)
(NASA-CR-175093; NAS 1.26:175093; D483-10060-1) Avail: NTIS HC A05/MF A01 CSCL 21H

The benefits of the utilization of effluents of the Space Station Environmental Control and Life Support (ECLS) system are examined. Various ECLSS-propulsion system interaction options are evaluated and compared on the basis of weight, volume, and power requirements. Annual propulsive impulse to maintain station altitude during a complete solar cycle of eleven years and the effect on station resupply are considered. Author

**N87-29595#** Ballistic Research Labs., Aberdeen Proving Ground, Md.
**SUPPRESSION WORKSHOP SUMMARY Final Report**
Joseph M. Heimerl 7 Apr. 1987 35 p Presented at a workshop on the Chemical Suppression of Rocket Afterburning and of Gun Muzzle Flash, Aberdeen, Md., 11-12 Jun. 1986
(AD-A182966; BRL-MR-3580) Avail: NTIS HC A03/MF A01 CSCL 19A

A workshop on the Chemical Suppression of Rocket Afterburning and of Gun Muzzle Flash was held at the Ballistic Research Laboratory on 11 and 12 June 1986. It brought together scientists representing six countries to share their collective fundamental understanding of the elementary, controlling processes in the generation of and the suppression of secondary combustion processes. This report is a distillation of the events of that workshop. It consists of short summaries of the 14 papers that form the Proceedings of the Workshop. Additional comments based on the discussion periods are appended to some of these summaries. In addition, an overall assessment of where this community stands and a list of recommendations for future directions and studies is supplied. GRA

**N87-29596#** Falcovitz (Joseph), Haifa (Israel).
**ANALYTICAL AND NUMERICAL COMPUTATION OF RING-SYMMETRIC SPACECRAFT EXHAUST PLUMES Contractor Report, Aug. - Dec. 1986**
Joseph Falcovitz Dec. 1986 60 p
(Contract N62271-86-M-0214; Grant MIPR-DGAA60045)
(AD-A183040; NPS-72-86-003CR) Avail: NTIS HC A04/MF A01 CSCL 20D

A doubleheader approach to the computation of a ring-symmetric spacecraft exhaust plume is presented. We plan to use the present analytic approximation in conjunction with a model for backflow from the exhaust plume of an orbiting spacecraft, induced by oncoming ambient molecules. This process takes place in the regions of centered rarefaction waves (CRW) that flank the central plume. A semi-inverse marching characteristic scheme (SIMA) is formulated specifically for accurate computation of a CRW in two-dimensional axisymmetric coordinates, as a variant of the classical inverse marching method. It replicates a Prandtl-Meyer flow exactly, resulting in an accurate marching scheme for axisymmetric CRW. The analytic approximation to a ring-symmetric CRW is formulated in two phases. An analysis of the flow near the corner using characteristic coordinates, results in fan-wise gradients of flow variables (Riemann invariants). These gradients are then used to extrapolate the flow field along fan characteristics from the presumably Prandtl-Meyer flow at the corner while matching exactly the cylindrically diverging flow along the unreflected portion of the CRW leading characteristic. The resulting approximation compares favorably with numerical (SIMA) computations, even at about 10 corner radii away from the corner. GRA

**N87-29597#** Falcovitz (Joseph), Haifa (Israel).
**NUMERICAL COMPUTATION OF RING-SYMMETRIC SPACECRAFT EXHAUST PLUMES Contractor Report, Jan. - Aug. 1986**
Joseph Falcovitz Jan. 1987 56 p
(Contract N62271-86-M-0214; Grant MIPR-DGAA60045)
(AD-A183041; NPS-72-87-001CR) Avail: NTIS HC A04/MF A01 CSCL 20D

This report supplements report NPS72-86-003CR (AD-A183040). It provides further details about the code JET and the numerical schemes on which it is based: inverse marching characteristic and semi-inverse marching characteristic (SIMA) schemes. The computational procedure is described is some detail. The principles of operation of the code JET are outlined, including a glossary of all major arrays, variables, and subroutines. Finally, the full listing of the JET code is reproduced.

**N87-29598#** Falcovitz (Joseph), Haifa (Israel).
**AMBIENT SCATTERING FROM RING-SYMMETRIC SPACECRAFT EXHAUST PLUME Contractor Report, Jan. - Mar. 1987**
Joseph Falcovitz Apr. 1987 66 p
(Contract N00228-87-C-3046)
(AD-A183076; NPS-72-87-003CR) Avail: NTIS HC A04/MF A01 CSCL 20D

A first-collision model is presented for the evaluation of return flux from the exhaust plume of a ring-symmetric HF/DF laser in LEO, generated by an incident flux of ambient molecules traveling at orbital speed. The steady plume is bounded by a pair of lip-centered rarefaction fans, and unless spacecraft attitude enables incident air molecules to reach the plume through the cavitation regions that extend beyond these fans, the spacecraft is shielded from ambient scattering by its own plume. Assuming hard-spheres collisions, the first-collision model is given by a simple closed-form expression that can be regarded as a source term for scattered exhaust molecules. This source term is integrated numerically throughout the fan, yielding the flux arriving at some surface target point. Quantitatively, it is shown that for a typical HF/DF laser exhaust the contamination level generated by ambient scattering is not significant. It is found that the maximum return flux of HF+DF constitutes about 2% of the incident ambient flux; this ratio will be nearly constant for LEO altitudes. The value of this flux ratio is shown to be dependent on the molecular collision model; it may change upon replacing the hard-speres approximation by a more realistic collision model. A possible modification of spacecraft charging by the exhaust was examined, including production of HF(-) and DF(-). The only significant effect seemed to be shadowing of the downstream half of the spacecraft GRA

**N87-29459*#** Naval Postgraduate School, Monterey, Calif.
**PARTICLE SIZING IN ROCKET MOTOR STUDIES UTILIZING HOLOGRAM IMAGE PROCESSING**
David Netzer and John Powers *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 589-606 Sponsored by AFRPL, Edwards AFB, Calif. (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 21H

# 23 CHEMISTRY AND MATERIALS (GENERAL)

**N87-29599*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**TRIBOLOGY THEORY VERSUS EXPERIMENT**
John Ferrante Oct. 1987 25 p Prepared for presentation at the NSF Workshop on Adhesion Science and Technology, Lake Tahoe, Calif., 15-16 Oct. 1987
(NASA-TM-100198; E-3791; NAS 1.15:100198) Avail: NTIS HC A02/MF A01 CSCL 07A

Tribology, the study of friction and wear of materials, has achieved a new interest because of the need for energy conservation. Fundamental understanding of this field is very complex and requires a knowledge of solid-state physics, material science, chemistry, and mechanical engineering. This paper is meant to be didactic in nature and outlines some of the considerations needed for a tribology research program. The approach is first to present a simple model, a field emission tip in contact with a flat surface, in order to elucidate important considerations, such as contact area, mechanical deformations, and interfacial bonding. Then examples from illustrative experiments are presented. Finally, the current status of physical theories concerning interfacial bonding are presented. Author

# 24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.
For ceramic materials see *27 Nonmetallic Materials.*

**N87-29600** ESDU International Ltd., London (England).
**ESTIMATION OF DAMPING IN LAMINATED AND FIBRE-REINFORCED PLATES**
Jun. 1985 35 p
(ESDU-85012; ISBN-0-85679-518-6; ISSN-0141-3961) Avail: ESDU

A program, listed in BASIC and FORTRAN, for the estimation of the material damping in a rectangular, laminated plate, with simply supported or clamped edges, vibrating in the lower frequency natural modes (up to the 5th mode) is presented. The procedure applies when laminae having the same material properties and orientations of their principal axes of orthotropy are symmetrically disposed about the midplane of the plate. Beam characteristic functions are used to define the mode shapes, and the analysis sums the contributions to energy dissipation from each lamina. The input includes individual lamina elastic properties, the calculation of which is treated in ESDU 83035, and damping properties. Curves are given to enable approximate values of damping in longitudinal and transverse flexure and in longitudinal shear to be estimated for each lamina. Guidance is given on the effect of various factors on the damping of fiber reinforced

laminated plates, and a practical worked sample illustrates the use of the method. ESDU

**N87-29601*#** Washington Univ., St. Louis, Mo. Lab. for Ultrasonics.
**QUANTITATIVE NON-DESTRUCTIVE EVALUATION OF POROUS COMPOSITE MATERIALS BASED ON ULTRASONIC WAVE PROPAGATION Semiannual Progress Report, 15 Mar. - 14 Sep. 1987**
James G. Miller 21 Sep. 1987 38 p
(Grant NsG-1601)
(NASA-CR-181275; NAS 1.26:181275) Avail: NTIS HC A03/MF A01 CSCL 11D

Porosity in composite media using ultrasonic waves is characterized. The derivation of local approximations to the Kramers-Kronig relations are presented and it is shown that they may also be applicable to systems that could conceivably exhibit considerable dispersion such as composite laminates containing porosity. B.G.

**N87-29602#** Argonne National Lab., Ill.
**EXPERIMENTAL AND THEORETICAL ANALYSIS OF BACKSCATTERING MECHANISMS IN FIBER-REINFORCED COMPOSITES**
R. A. Roberts, J. Qu, and J. D. Achenbach Apr. 1987 28 p Presented at the Symposium on Acousto-Ultrasonics, Blacksburg, Va., 12 Jul. 1987 Prepared in cooperation with Northwestern Univ., Evanston, Ill.
(Contracts W-7405-eng-82; W-31109-ENG-38)
(DE87-011394; CONF-870776-1) Avail: NTIS HC A03/MF A01

This paper examines experimental measurements of polar backscatter following the techniques first employed by Bar-Cohen and Crane, and later by others. Experimental measurements of the angular dependence of ultrasonic backscatter are presented for fiber reinforced composite specimens (epoxy-carbon fiber) containing various levels of porosity. This data demonstrates how backscattered signals from porosity are inseparably intertwined with signals scattered by the internal fiber-related structures of the composite. DOE

**N87-29603#** Oak Ridge National Lab., Tenn.
**ASSESSMENT OF CERAMIC COMPOSITES FOR MMW SPACE NUCLEAR POWER SYSTEMS**
T. M. Besmann 1987 5 p Presented at the 4th Symposium on Space Nuclear Power Systems, Albuquerque, N. Mex., 12 Jan. 1987
(Contract DE-AC05-84OR-21400)
(DE87-002404; CONF-87U102-6) Avail: NTIS HC A02/MF A01

Proposed multimegawatt nuclear power systems which operate at high temperatures, high levels of stress, and in hostile environments, including corrosive working fluids, have created interest in the use of ceramic composites as structural materials. This report assesses the applicability of several ceramic composites in both Brayton and Rankine cycle power systems. This assessment considers an equilibrium thermodynamic analysis and also a nonequilibrium assessment. DOE

**N87-29604*#** Texas A&M Univ., College Station. Dept. of Mechanical Engineering.
**MICROMECHANICS OF COMPRESSION FAILURES IN OPEN HOLE COMPOSITE LAMINATES Annual Progress Report, Apr. 1986 - Aug. 1987**
E. Gail Guynn and Walter L. Bradley Sep. 1987 227 p
(Grant NAG1-659)
(NASA-CR-181278; NAS 1.26:181278) Avail: NTIS HC A11/MF A01 CSCL 11D

The high strength-to-weight ratio of composite materials is ideally suited for aerospace applications where they already are used in commercial and military aircraft secondary structures and will soon be used for heavily loaded primary structures. One area impeding the widespread application of composites is their inherent weakness in compressive strength when compared to the tensile properties of the same material. Furthermore, these airframe designs typically contain many bolted or riveted joints, as well as electrical and hydraulic control lines. These applications produce areas of stress concentration, and thus, further complicate the compression failure problem. Open hole compression failures which represent a typical failure mode for composite materials are addressed. B.G.

**N87-29605#** Sandia National Labs., Albuquerque, N. Mex.
**THERMAL CONDUCTIVITY OF BORON CARBIDES**
M. Moss 1987 7 p Presented at the Spring Meeting of the Materials Research Society, Anaheim, Calif., 21 Apr. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012016; SAND-86-2666C; CONF-870438-31) Avail: NTIS HC A02/MF A01

The thermal conductivity, k, of boron carbides of various B/C ratios, two modes of preparation - hot pressed and carbothermic, and two isotopic variants of boron - (B-11) and normal boron B-10.81, was measured from 300 to 1023 K. The density and composition of the samples were reflected in the magnitude and temperature dependence of k, and were investigated further with scanning electron microscopy, Rutherford backscattering spectroscopy, and Raman spectroscopy. While lower than theoretical density in B4C reduces k, the characteristic monotonic decline of k with increasing temperature is retained. This k-vs.-T behavior distinguishes B4C from material with larger B/C ratios for which the temperature dependence is essentially nil. DOE

**N87-29606#** Pacific Northwest Labs., Richland, Wash.
**IMPROVED CERAMIC COMPOSITES THROUGH FIBER-MATRIX INTERACTION**
J. L. Bates, C. W. Griffin, W. J. Weber, and E. L. Courtright May 1987 16 p Presented at the Fossil Energy Materials Program Conference, Oak Ridge, Tenn., 19 May 1987
(Contract DE-AC06-76RL-01830)
(DE87-013326; PNL-SA-14930; CONF-8705103-10) Avail: NTIS HC A02/MF A01

Preliminary analyses of matrix/fiber interactions between Si3N4 matrix with 5 wt.% MgO added as a sintering aid, and Nicalon silicon carbide fibers have been performed. Specimens with 0, 10, and 30 vol.% fibers were prepared by hot pressing at 1750°C in one atmosphere of nitrogen. Specimen characterization revealed that a significant amount of magnesium diffuses into the silicon carbide fibers during fabrication. Free carbon on the surface of the Nicalon appears to play an important role in debonding. No evidence of Si enrichment or SiO2 formation have been found at the interfaces. DOE

**N87-29607#** Bristol Univ. (England). Dept. of Aeronautical Engineering.
**THEORETICAL INVESTIGATIONS OF STRESS CONCENTRATIONS IN CARBON FIBRE REINFORCED PLASTIC PLATE STRUCTURES Ph.D. Thesis**
Chi-Man Lawrence Wu Mar. 1986 357 p
(Contract MOD-ER/A/4/2034/064)
(ETN-87-90710) Avail: NTIS HC A16/MF A01

A quasi-three-dimensional quadrilateral isoparametric finite element for the linear-elastic and nonlinear static stress analysis of composite laminates subjected to a uniform in-plane load was developed. Linear-elastic numerical results are obtained for the free edge stress problems of (0/90)s and (+/-45)s laminates using the quasi-three-dimensional element are obtained. The quasi-three-dimensional element is also used to analyze variable thickness (stepped) laminated plates of infinite width. An initial stress iteration method using the quasi-three-dimensional element for the nonlinear analysis of CFRP laminates was developed. ESA

**N87-29608#** Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.
**RESIDUAL STRESS IN A 3D CARBON-CARBON COMPOSITE**
L. A. Feldman 30 Sep. 1986 13 p
(Contract F04701-85-C-0086)
(AD-D440674; TOR-0086(6728-02)-4) Avail: NTIS HC A02/MF A01 CSCL 11D

(AD-D440674; TOR-0086(6728-02)-4) Avail: NTIS HC A02/MF A01 CSCL 11D

Residual stress is measured in a thin slice from a carbon-carbon composite with a 3D Cartesian weave. The curvature of a slice of asymmetric cross section indicates the amount of stress caused by thermal expansion anisotropy. Author

**N87-29609*#** Boeing Commercial Airplane Co., Seattle, Wash.
**THE 737 GRAPHITE COMPOSITE FLIGHT SPOILER FLIGHT SERVICE EVALUATION Progress Report, 1 Jan. 1985 - 31 Dec. 1986**
Randy L. Coggeshall Aug. 1987 43 p
(Contract NAS1-11668)
(NASA-CR-178322; NAS 1.26:178322; PR-9) Avail: NTIS HC A03/MF A01 CSCL 11D

The ninth flight service report was prepared in compliance with the requirements of Contract NAS1-11668. It covers the flight service experience of 111 graphite-epoxy spoilers on 737 transport aircraft and related ground-based environmental exposure of graphite epoxy material specimens for the period 1 Jan. 1985 through 31 Dec. 1986. Spoilers have been installed on 28 aircraft representing seven major airlines operating throughout the world. An extended flight service evaluation program of 15 years is presently underway. As of 31 Dec. 1986, a total of 3,339,608 spoiler flight-hours and 3,320,952 spoiler landings had been accumulated by this fleet. Author

**N87-29610#** Massachusetts Inst. of Tech., Cambridge. Technology Lab. for Advanced Composites.
**POST-BUCKLING, DAMAGE TOLERANCE AND MANUFACTURING TECHNIQUES FOR ADVANCED COMPOSITE MATERIALS Final Report, Jun. 1983 - Jun. 1986**
John Dugundji, Paul A. Lagace, James W. Mar, and Theodore H. Pian Aug. 1986 66 p
(Contract F33615-83-K-5016)
(AD-A183288; TELAC-86-23; AFWAL-TR-87-4006) Avail: NTIS HC A04/MF A01 CSCL 11D

This report describes a basic research program to study the post-buckling, the damage tolerance, and manufacturing techniques for various built-up, composite structures. Five separate investigations are briefly summarized here. These dealt with (1) buckling and failure studies of integrally stiffened graphite/epoxy panels, (2) finite element and experimental studies of buckling of laminated thin-wall, graphite structures, (3) damage tolerance of pressurized graphite/epoxy cylinders flawed with slits and holes, and (4) damage tolerance of graphite/epoxy cylinders with a high strain-to-failure matrix system. These studies help provide information on the use of graphite/epoxy composites in heavily loaded structures. For more thorough descriptions and details, refer to the individual reports cited here. GRA

**N87-29611#** Naval Research Lab., Washington, D.C.
**THERMAL EXPANSION OF COMPOSITES WITH SPHERICAL AND CYLINDRICAL INCLUSIONS Final Report**
Paul G. Klemens 21 Jul. 1987 18 p
(AD-A183390; NRL-MR-5820) Avail: NTIS HC A02/MF A01 CSCL 11D

The strain field about a spherical inclusion consists of a uniform dilation and a short-range field which has pure shear character. By minimizing the strain energy, these fields are expressed in terms of the misfit of the inclusion. For a finite concentration of inclusions, the average properties of the material are used in place of those of the matrix. The thermal expansion of a composite containing spherical inclusions of different expansion coefficient is then obtained, again replacing the expansion coefficient of the matrix by that of the material as a whole. When the shear strain around the inclusion becomes large enough for plastic flow to occur, it suffices to modify the shear modulus approximately, since most of the shear strain energy is concentrated at the matrix-inclusion interface. The strain filed about an infinitely long cylindrical inclusion can also be resolved into a uniform dilation and a short-range shear strain field, and expressions for the thermal expansion of a composite with long fiber inclusions, randomly oriented, are obtained in a similar manner. GRA

**N87-29612*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**THE ACEE PROGRAM AND BASIC COMPOSITES RESEARCH AT LANGLEY RESEARCH CENTER (1975 TO 1986): SUMMARY AND BIBLIOGRAPHY**
Marvin B. Dow Oct. 1987 147 p
(NASA-RP-1177; L-16290; NAS 1.61:1177) Avail: NTIS HC A07/MF A01 CSCL 11D

Composites research conducted at the Langley Research Center during the period from 1975 to 1986 is described, and an annotated bibliography of over 600 documents (with their abstracts) is presented. The research includes Langley basic technology and the composite primary structures element of the NASA Aircraft Energy Efficiency (ACEE) Program. The basic technology documents cited in the bibliography are grouped according to the research activity such as design and analysis, fatigue and fracture, and damage tolerance. The ACEE documents cover development of composite structures for transport aircraft. Author

# 25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

**N87-29613** ESDU International Ltd., London (England).
**VAPOUR PRESSURES AND CRITICAL POINTS OF LIQUIDS. PART 1C: C10 TO C24 ALKANES**
Feb. 1985 49 p
(ESDU-85002; ISBN-0-85679-508-9; ISSN-0141-4062) Avail: ESDU

Vapor pressure data for 30 alkanes are given. The data were obtained from a critical evaluation of experimental results in the literature, extrapolated by a recent reliable method into the low pressure region, and fitted by a Wagner equation applying over the full range from freezing to the critical point. The tables of vapor pressure are included: in SI units at 5 K intervals, in atmospheres at 5 C intervals, in 1 bf/sq in at 10 F intervals. The sources of the data used are listed, and a table gives likely uncertainties in values predicted by the equation that should be allowed for in any critical situation. Critically evaluated data for alkanes with molecules containing 1 to 7 or 8 and 9 carbon atoms are found respectively in ESDU 84022 or 84028, while notes on the correlation technique are given in ESDU 84021. ESDU

**N87-29614#** Brigham Young Univ., Provo, Utah. Dept. of Chemistry.
**SUPERCRITICAL FLUID CHROMATOGRAPHY/SUPERSONIC JET SPECTROSCOPY Progress Report, 16 Mar. - 1 Jun. 1987**
S. R. Goates and M. L. Lee 1987 9 p
(Contract DE-FG22-86PC-90534)
(DE87-012717; DOE/PC-90534/5) Avail: NTIS HC A02/MF A01

We have struggled this past quarter with sensitivity, but improvements in the mount for the fluorescence deflection mirror seems to have gotten us back on track. Additionally, focusing the excitation beam onto the jet with a one meter lens has improved the signal, both by increasing excitation intensity at the focal point and by allowing the beam to be brought closer to the jet nozzle. These observations were made with direct expansions through small pinhole nozzles; we may find that a broader beam or a cylindrically focused beam will be better suited to some of the other nozzle arrangements we are investigating, where supersonic flow may develop farther away from the nozzle. However, one of the primary benefits of focusing the beam was to drastically reduce stray light scattering off the nozzle. Stray light has continued to be a major limitation despite the light baffles we employ in the

excitation beam path. For further experiments with the unfocused beam we plan to use a telescope with spatial filter to clean up the beam fringes. We continue to improve the automation and computer control of our equipment, and while we are still delayed with the implementation of the array detector, programming routines for signal processing are nearly complete. Automation of temperature control of the thermal interface from chromatograph to vacuum chamber has also been done. Laser-induced fluorescence (LIF) detection has been our method of choice as we work to solve many of the problems associated with coupling supersonic jet spectroscopy to supercritical fluid chromatography, but a major goal of this work is to pursue other spectroscopic detection methods. DOE

**N87-29615#** Southern Research Inst., Birmingham, Ala.
**PIC (PRODUCTS OF INCOMPLETE COMBUSTION) ANALYSIS METHODS Final Report, Mar. 1984 - Apr. 1985**
R. H. James, L. B. Farr, R. E. Adams, and H. C. Miller Jun. 1987 530 p
(Contract EPA-68-02-3696)
(PB87-208955; SORI-EAS-86-1142; EPA/600/9-87/011) Avail: NTIS HC A23/MF A01 CSCL 21B

Results are given of method evaluations for products of incomplete combustion (PICs): 36 proposed PICs were evaluated by previously developed gas chromatography/flame ionization detection (GC/FID) and gas chromatography/mass spectroscopy (GC/MS) methods. Results are also given of method evaluations of 59 additional principal organic hazardous constituents (POHCs) from the amended list of compounds from Appendix 8 of 40 CFR, Part 261. Presented are chromatograms, bar graph mass spectra, and calibration curves for each compound. Relative retention time, detection limits, precision data, and mass spectra are tabulated for each compound. Recent literature on the formation of PICs is reviewed. GRA

**N87-29616#** National Materials Advisory Board, Washington, D.C.
**PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON THE EXPLOSION HAZARD CLASSIFICATION OF VAPORS, GASES AND DUSTS**
1987 348 p Symposium held in Washington, D.C., 15-18 Jul. 1986 Sponsored by Occupational Safety and Health Administration, Washington, D.C.
(PB87-201943; OSHA/RP-87/003) Avail: NTIS HC A15/MF A01 CSCL 21B

The purpose of the Symposium was to bring together internal experts for an intensive exchange of knowledge and thinking on classification of gases, vapors, and dusts. The format of the symposium consisted of formal presentations first, followed by panel and audience discussions and ended with a session dealing with where to go in the future. Among the topics covered were: material classification in several countries, standards, early research, testing, needs, and fundamental problems. GRA

**N87-29617#** Los Alamos National Lab., N. Mex.
**VIBRATIONAL SPECTROSCOPY OF SHOCK-COMPRESSED FLUID N2 AND O2**
S. C. Schmidt, D. S. Moore, M. S. Shaw, and J. D. Johnson 1987 15 p Presented at the 11th International AIRAPT Conference, Kiev, USSR, 12 Jul. 1987
(Contract W-7405-eng-36)
(DE87-011730; LA-UR-87-2228; CONF-870754-2) Avail: NTIS HC A02/MF A01

Single-pulse multiplex coherent anti-Stokes Raman scattering (CARS) was used to observe the vibrational spectra of liquid N2 shock-compressed to several pressures and temperatures up to 41 GPa and 5200 K and liquid O2 shock-compressed to several pressures and temperatures up to 10 GPa and 1000 K. For N2, the experimental spectra were compared to synthetic spectra calculated using a semiclassical model for CARS intensities and estimated vibrational frequencies, peak Raman susceptibilities, and Raman line widths. The question of excited state populations in the shock-compressed state is addressed. DOE

**N87-29618#** Lawrence Livermore National Lab., Calif.
**PHASE CHANGES AND CHEMISTRY AT HIGH PRESSURES AND TEMPERATURES**
F. H. Ree Jul. 1987 7 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract W-7405-eng-48)
(DE87-012625; UCRL-96525; CONF-870753-34) Avail: NTIS HC A02

Some of the interesting changes that occur in nature involve phase changes and chemical reactions at high pressures and temperatures. This paper gives new equilibrium and nonequilibrium calculations on reactive mixtures and a review on recent theoretical works in this field. DOE

**N87-29619#** California Univ., Berkeley. Lawrence Berkeley Lab.
**A COMPARISON OF VELOCITY AND SCALAR SPECTRA IN PREMIXED TURBULENT FLAMES**
R. K. Cheng, I. G. Shepherd, and I. Gokalp May 1987 10 p Presented at the 6th Symposium on Turbulent Shear Flow, Toulouse, France, 7 Sep. 1987 Prepared in cooperation with California Univ., Berkeley and Centre National de La Recherche Scientifique, Orleans, France
(Contract DE-AC03-76SF-00098)
(DE87-011099; LBL-23521; CONF-870989-1) Avail: NTIS HC A02

Scalar (intermittency) and velocity spectra in premixed methane/air turbulent v-flames and stagnation flow stabilized flames have been measured using laser light Mie scattering and laser Doppler anemometry techniques. To compare the velocity spectra of the oblique v-flame with those of the normal stagnation flames, the velocity data for v-flames are transformed to obtain the spectra of the velocity components normal and tangential to the oblique flame zone. In both configurations, the spectra of the normal velocity components are similar to the corresponding scalar spectra. The most energetic frequencies are consistent with the flame passage frequencies demonstrating clearly that the velocity and scalar spectra are strongly coupled. However, the most energetic frequencies are about an order of magnitude higher in the v-flame than in the stagnation flames even though the incidence turbulence of the two flames is similar. Since this difference does not seem to be proportional to the difference in the mean velocities, our results imply that the spatial scales in the two flame zones are not the same. DOE

**N87-29620#** Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
**THEORETICAL TREATMENT OF THE PHOTODISSOCIATION OF WATER IN THE FIRST ABSORPTION BANDS Thesis [THEORETISCHE BEHANDLUNG DER PHOTODISSOZIATION VON WASSER IN DER ERSTEN ABSORPTIONSBANDE]**
V. Engel Oct. 1986 117 p In GERMAN
(MPIS-14/1986; ISSN-0436-1199; ETN-87-90321) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 25

The absorption spectrum of the photodissociation process of water, and the vibration distributions, summed over all final rotations of the fragment, were calculated. It is shown that, using mass-scaled polar coordinates, continum functions, which describe a reactive, colinear process, can be calculated numerically. The resulting absorption spectra show symmetry-dependent resonances. An interpretation of a dissociation cross section of the (colinear) CO2 system is presented. It is shown that the three-dimensional treatment of the H2O dissociation process can be reduced to a two-dimensional, reactive problem. The quantum-mechanical calculation of the photofragmentation of the H2O-and D2O molecules in the first absorption band show very good agreement with measured absorption spectra. Spectra of the photolysis process of water from vibrationally excited state were calculated. ESA

**N87-29621#** Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
**INVESTIGATION OF THE REACTION OF ELECTRONICALLY EXCITED OXYGEN O2 (1 DELTA g) WITH RADICALS AND MOLECULES IN THE GAS PHASE Thesis [UNTERSUCHUNG DER REAKTION ELEKTRONISCH ANGEREGTEN SAUERSTOFFS 02 (1 DELTA G) MIT RADIKALEN UND MOLEKUELEN IN DER GASPHASE]**
Eckhard Fiedler Dec. 1986 100 p In GERMAN
(MPIS-15/1986; ISSN-0436-1199; ETN-87-90322) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 22

Rate constants and reaction products of the reactions of metastable O2 (1 delta g) with radicals as well as with molecules were investigated in an isothermal flow reactor with movable admixture probe, at room temperature. The samples from the reaction mixture were directly and continuously introduced into the ion source of a quadropole mass spectrometer via a molecular beam inlet system, and analyzed. This method allows the determination of small concentrations of the starting products as well as of the reaction products. The interaction of O2 (1 delta g) in a methyl-oxygen system due to energy transfer processes and chemical reactions is elucidated. The isotope effect of the CO3 radical is determined. ESA

**N87-29622#** Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
**INVESTIGATION OF THE MECHANISM OF SPECIAL RADICAL REACTIONS IN THE SYSTEM H-N-C-O Thesis [UNTERSUCHUNG DES MECHANISMUSSES SPEZIELLER RADIKALREAKTIONEN IM H-N-C-O-SYSTEM]**
P. Dransfeld Dec. 1986 156 p In GERMAN
(MPIS-17/1986; ISSN-0436-1199; ETN-87-90324) Avail: NTIS HC A08/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 33

The rate constants and the products of radical reactions in the system H-N-C-O were obtained in a flow system with a combination of electron spin resonance and laser magnetic resonance for the detection of the atoms H, O, N, and F, and the radicals 16 OH, 18 OH, NH2, and HO2. The distributions of the products show that radical reactions follow a way over an additional complex which stabilizes or decays depending on the reactions conditions. The fragmentation remains frequently hidden, but can be uncovered using isotope-marking reaction products, as shown for the reactions of OH 18 with NO, NO2, and HO2. ESA

**N87-29623#** Battelle Inst., Frankfurt am Main (West Germany).
**SHAPE, VIBRATIONS AND STABILITY OF LIQUID SURFACES Final Report, Jun. 1984**
Dieter Langbein and Fritz Rischbieter Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 131 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-W-86-029; ISSN-0170-1339; ETN-87-90331) Avail: NTIS HC A07/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 27.50

The deformations and stability of liquid surfaces were studied. The second variation of the energy of liquid surfaces with respect to all possible surface deformations was deduced, and it was checked whether it is positive definite. The differential equation of the resulting normal deformations was derived. The stability diagrams of axisymmetric surfaces between coaxial disks are given, emphasizing the stability of axisymmetric surfaces in dependence on gravity. A dynamical model of surface deformations was developed, presuming a high viscosity of the liquid. A surface instability automatically causes divergence of the numerical method. An iterative finite element method was developed to study nonaxisymmetric, three-dimensional surfaces, in particular in rectangular boxes. Depending on the liquid volume, the wetting angle, and the gravity, there are closed surfaces, surfaces exhibiting a dry spot in the center, surfaces extending along the edges of the box, and surfaces located in the corners. ESA

**N87-29624#** Dortmund Univ. (West Germany). Lehrstuhl Mechanische Verfahrenstechnik.
**GAS SEPARATION WITH MEMBRANE SYSTEMS: FROM LABORATORY SIZE TO A PROTOTYPE Final Report, Oct. 1985**
Udo Werner, Norbert Brink, Udo Eickmann, Klaus-Dieter Kothe, and Henning Wonsak Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 96 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-86-126; ISSN-0340-7608; ETN-87-90333) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 20

A membrane rectification column was developed and tested for gas separation. The experiments included the extensive characterization of nonporous polymeric and microporous membranes, the separation of gas mixtures in a capillary and plate module, and the analysis of the efficiency of different arrangements. The results of the experiments were compared with theoretical models, with varying agreement. Methods for the calculation of the pressure loss in systems with porous membranes were elaborated. The membrane rectification process was economically compared with other arrangements, for several applications. ESA

**N87-29625#** Wisconsin Univ., Madison. Dept. of Chemistry.
**A NEW CLASS OF CHEMICAL SENSORS FOR GASES BASED ON PHOTOLUMINESCENCE FROM SEMICONDUCTOR-DERIVED INTERFACES Technical Report, 25 Apr. 1987**
Gerald J. Meyer, George C. Lisensky, and Arthur B. Ellis 8 Jul. 1987 13 p
(Contract N00014-85-K-0631)
(AD-A182962; UWIS/DC/TR-87/5) Avail: NTIS HC A02/MF A01 CSCL 20L

The photoluminescence (PL) of semiconductors can be perturbed by exposure of the solid to gases. These physicochemical interactions occurring at the semiconductor surface can be exploited to create a new class of chemical sensors. For homogeneous semiconductors, a dead-layer model has been used to correlate changes in PL intensity with variations in the depletion width W caused by the gas. A graded n-CdSxSe1-x substrate permits modulation of the PL spectral distribution by gases and is color-coded to permit PL changes to be correlated with variations in the effective electric field present in the solid. Three semiconductors that have been chemically derivatized with ferrocene can sense volatile oxidants and reductants; and etched semiconductors can respond to sulfur dioxide and ammonia, presumably through acid-base interactions. All of the structures lend themselves to device fabrication by use of optical fiber technology. GRA

**N87-29626#** California Univ., Irvine. Dept. of Information and Computer Science.
**TOWARDS AN INTEGRATED DISCOVERY SYSTEM Interim Report, Jan. - Mar. 1987**
Bernd Nordhausen and Pat Langley 27 Jul. 1987 14 p
(Contract MDA903-85-C-0324)
(AD-A183237; UCI-ICS-TR-87-18; TR-1) Avail: NTIS HC A02/MF A01 CSCL 07D

Previous research on machine discovery has focused on limited parts of the empirical discovery task. This paper describes IDS, an integrated discovery system that addresses both qualitative and quantitative discovery. The program represents its knowledge in terms of qualitative schemas, which it discovers by interacting with a simulated physical environment. Once IDS has formulated a qualitative schema, it uses that schema to design experiments and to constrain the search for quantitative laws. The authors have carried out preliminary tests in the domain of heat phenomena. In this context the system has discovered both intrinsic properties, such as the melting point of substances, and numeric laws, such as the conversation of mass for objects going through a phase change. GRA

**N87-29627#** Science Applications International Corp., Sunnyvale, Calif.
**KEVLAR PHOTOCHEMICAL DEGRADATION MECHANISMS Final Report, 1 Oct. 1983 - 30 Apr. 1986**
Madeline S. Toy Apr. 1987 38 p
(Contract N60530-83-C-0112)
(AD-A183273; NWC-TM-6007) Avail: NTIS HC A03/MF A01 CSCL 07B

Investigated are Kevlar's photochemical degradation mechanisms, rate constants, and activation energies in air. The purpose is to understand the oxidative photodegradation processes, which would help to provide service life forecast under sunlight conditions and to protect it from photodecomposition. The first significant accomplishment of the project was the new and novel analytical approach, which demonstrated the rate constant and activation energy determinations of Kevlar's photooxidative processes. The 0.2 atm of oxygen-18-labeled environment in a solar chamber simulates the air exposure under sunlight conditions. The technique also allows the radial Oxygen-18 distribution measurement from the fiber surface toward the fiber center. The data from the accelerated experimental conditions in the solar chamber in a diatomic oxygen-18 atmosphere are differentiated from the similar ambient daylight exposure effects. The second significant accomplishment was the recognition of a thermal decomposition pattern of Kevlar in concentrated sulfuric acid at 196 C to give the same two types of decarboxylations: one yields one mole of carbon dioxide per (C7H5NO) moiety and the other gives two moles of CO2 per (C7H5NO) moiety. The third significant accomplishment was the analytical methodology applied to deduce the four photooxidative processes. GRA

**N87-29628#** IBM Research Lab., San Jose, Calif.
**STATISTICAL FINE STRUCTURE OF INHOMOGENEOUSLY BROADENED ABSORPTION LINES**
W. E. Moerner and T. P. Carter 31 Jul. 1987 15 p
(Contract N00014-84-C-0708)
(AD-A183652; TR-13) Avail: NTIS HC A02/MF A01 CSCL 20E

Using laser frequency-modulation spectroscopy, we have observed statistical fine structure (SFS) in the inhomogeneously broadened optical absorption of pentacene in p-terphenyl at liquid helium temperatures. SFS is the actual frequency-dependent, time-independent structure of the inhomogeneous line caused by the randomly varying number of centers in each frequency interval. The size of the SFS varies as the square root of the number of centers, and the autocorrelation of the SFS yields an estimate of the homogeneous linewidth without requiring spectral hole-burning or coherent transients. GRA

**N87-29629#** Illinois Univ., Urbana. Dept. of Mechanical and Industrial Engineering.
**HIGH-SPEED REACTING FLOWS: RESEARCH TO UNDERSTAND PROCESSES IN SUPERSONIC COMBUSTORS Annual Letter Report, 1 Jun. 1986 - 31 May 1987**
H. Krier, J. C. Dutton, and J. P. Renie 31 May 1987 4 p
(Contract N00014-86-K-0434)
(AD-A183952) Avail: NTIS HC A02/MF A01 CSCL 21B

The objective of this program is to determine the fundamental fluid dynamic mechanisms occurring in the mixing and entrainment processes in the free shear layer formed between two high-speed (supersonic/sonic) streams. How the fluid mixing and subsequent combustion depends upon compressibility, as well as other parameters of the free shear layer process, is currently being investigated in an experimental study of the two-dimensional, compressible, turbulent reactive free shear layer. Use of non-intrusive, laser-based diagnostics including laser Schlieren for flow visualization, Laser Doppler Velocimetry (LDV) for velocity and turbulence measurement, and Planar Laser-Induced Fluorescence (PLIF) for temperature and concentration measurements are being employed. GRA

**N87-29630*#** Eloret Corp., Sunnyvale, Calif.
**THEORETICAL RESEARCH PROGRAM TO STUDY TRANSITION METAL TRIMERS AND EMBEDDED CLUSTERS Final Technical Report, 1 Jul. 1984 - 30 Jun. 1987**
Stephen P. Walch 12 Oct. 1987 16 p
(Contract NCC2-296)
(NASA-CR-181379; NAS 1.26:181379) Avail: NTIS HC A02/MF A01 CSCL 07D

The results of ab-initio calculations are reported for (1) small transition metal clusters and (2) potential energy surfaces for chemical reactions important in hydrogen combustion and high temperature air chemistry. Author

**N87-29631*#** Eloret Corp., Sunnyvale, Calif.
**ON nd BONDING IN THE TRANSITION METAL TRIMERS: COMPARISON OF Sc3 AND Y3**
Stephen P. Walch [1987] 21 p
(Grant NAG2-296)
(NASA-CR-181378; NAS 1.26:181378) Avail: NTIS HC A02/MF A01 CSCL 07D

CASSCF/CCI calculations are presented for the low-lying states of Y3. Comparison of the wave functions for Y3 and Sc3 indicates substantial 4d-5p hybridization in Y3, but little 3d-4p hybridization in Sc3. The increased 4d-5p hybridization leads to stabilization of 4dpi bonding with respect to 4dsigma bonding for equilateral triangle Y3, and also leads to 4d-5p bonding for linear geometries. These effects lead to a different ordering of states for equilateral triangle geometries and a smaller excitation energy to the linear configuration for Y3 as compared to Sc3. Author

**N87-29632*#** Eloret Corp., Sunnyvale, Calif.
**A THEORETICAL STUDY OF THE EXCITED STATES OF Ag3**
Stephen P. Walch [1987] 5 p
(Contract NCC2-296)
(NASA-CR-181377; NAS 1.26:181377) Avail: NTIS HC A02/MF A01 CSCL 07D

Recently there was considerable interest in the properties and reactivities of small metal clusters. However, for the transition metal trimers, gas phase spectroscopy exists only for Cu3. Calculations are reported for the excited states of the Ag3 molecule. The excitation energies, geometries, derived harmonic frequencies, and transition moments are presented. The electronic structure of these states is very similar to the analogous states of Cu3. From the VCI wave functions transition moments were calculated between each of the Rydberg excited states and the ground state for an equilateral triangle geometry with R sub Ag-Ag = 5.3 a sub 0. One state was computed for the configuration 4d29 5sa sup prime 2 sub 1 5se sup prime 1 sub x 5se sup prime 1 sub y. This configuration was considered since the corresponding configuration for Cu3 is low-lying. Calculations were carried out for a quartet wavefunction in which the 4d hole was localized on the central Ag atom. The spectrum for Ag3 is expected to be simpler than for Cu3 since the 5s2 4d9 states are shifted to higher energy. B.G.

**N87-29633*#** Case Western Reserve Univ., Cleveland, Ohio. Dept. of Physics.
**OXYGEN INTERACTION WITH SPACE-POWER MATERIALS Annual Report, 1 May 1986 - 30 Apr. 1987**
T. G. Eck and R. W. Hoffman Oct. 1987 16 p
(Grant NAG3-696)
(NASA-CR-181396; NAS 1.26:181396) Avail: NTIS HC A02/MF A01 CSCL 07D

Data from the space shuttle flights have established that many materials experience relatively rapid degradation when exposed to the low Earth orbit ambient atmosphere, which is predominately atomic oxygen. While much was learned from samples flown on the shuttle, laboratory simulations of the shuttle environment are necessary for a detailed understanding of the various interactions which contribute to the observed degradations. These laboratory experiments are particularly important for predicting the deterioration to be expected for materials aboard orbiting power systems, which will be exposed for long periods of time and could

have components operating at very high temperatures. By using a mass spectrometer to synchronously detect molecules emitted from the surface as a result of amplitude modulated oxygen ion bombardment, quantum yields were obtained as a function of ion energy. A technique was developed to obtain preliminary yield data by slowly scanning the mass setting of the mass spectrometer; measurements were extended down to zero modulation frequency; yield data was obtained for the insulating materials (Nomex, Kevlar, and Teflon) used in the construction of electrodynamic tethers; a heated sample holder was constructed to investigate the effect of sample temperature on quantum yields; and the instrumentation was developed to observe the mass spectrometer signal as a function of time during and following bombardment of the sample by a brief (approximately 1 millisecond) pulse of ions. Author

**N87-29634*#** Alabama Univ., Huntsville. Dept. of Mechanical Engineering.
**DEVELOPMENT OF COMPUTERIZED ANALYSIS FOR SOLID PROPELLANT COMBUSTION (ISAP-2) Semiannual Report**
T. J. Chung and Raymond Hallit Nov. 1987 78 p
(Grant NAG8-627)
(NASA-CR-181399; NAS 1.26:181399) Avail: NTIS HC A05/MF A01 CSCL 21B

This report is an improvement of ISAP-1, SRB Vorticity-Acoustic Coupled Instability Analysis, September 1986. Included in this report are the automatic generation of all input data for grid configuration, boundary conditions for coupled acoustic and vortical field calculations, transformation of all dimensions to a parametric form, resulting in flexibility for the user to define the size of the problem (geometric configurations) with reduction in storage (15 to 65%) and computer run-time (50 to 75%). Additional research is required for the following areas: (1) turbulence effects; (2) nonlinear wave oscillations; and (3) chemistry upon combustion instability.
Author

**N87-29635*#** Drexel Univ., Philadelphia, Pa. Dept. of Mechanical Engineering and Mechanics.
**SPARK IGNITION OF MONODISPERSE FUEL SPRAYS Ph.D. Thesis**
Allen M. Danis, Nicholas P. Cernansky, and Izak Namer Sep. 1987 150 p
(Grant NAG3-382)
(NASA-CR-181404; NAS 1.26:181404) Avail: NTIS HC A07/MF A01 CSCL 21B

A study of spark ignition energy requirements was conducted with a monodisperse spray system allowing independent control of droplet size, equivalent ratio, and fuel type. Minimum ignition energies were measured for n-heptane and methanol sprays characterized at the spark gap in terms of droplet diameter, equivalence ratio (number density) and extent of prevaporization. In addition to sprays, minimum ignition energies were measured for completely prevaporized mixtures of the same fuels over a range of equivalence ratios to provide data at the lower limit of droplet size. Results showed that spray ignition was enhanced with decreasing droplet size and increasing equivalence ratio over the ranges of the parameters studied. By comparing spray and prevaporized ignition results, the existence of an optimum droplet size for ignition was indicated for both fuels. Fuel volatility was seen to be a critical factor in spray ignition. The spray ignition results were analyzed using two different empirical ignition models for quiescent mixtures. Both models accurately predicted the experimental ignition energies for the majority of the spray conditions. Spray ignition was observed to be probabilistic in nature, and ignition was quantified in terms of an ignition frequency for a given spark energy. A model was developed to predict ignition frequencies based on the variation in spark energy and equivalence ratio in the spark gap. The resulting ignition frequency simulations were nearly identical to the experimentally observed values.
Author

**N87-29636** Princeton Univ., N. J.
**TWO-DIMENSIONAL VISUALIZATION OF PREMIXED CHARGE FLAME STRUCTURE IN AN IC ENGINE Ph.D. Thesis**
Axel Otto zurLoye 1987 459 p
Avail: Univ. Microfilms Order No. DA8712521

Spark kernels and flame fronts in a premixed-charge, spark-ignition, ported engine were examined for the first time with two-dimensional spatial resolution. The engine was operated at speeds between 300 and 3000 rpm with stoichiometric propane/air mixtures and also near the lean limit. A pulsed laser sheet was passed through the engine and Mie scattering by TiO2 or ZrO2 seeding particles was collected by a diode array. Images of flame fronts were obtained with up to 200 microns spatial resolution and 10 nanoseconds time resolution. The results lend strong support to the theory that in the reaction sheet regime the increase of the turbulent flame speed over the laminar flame speed is caused primarily by an increase in the surface area of the flame sheet. The thickness of the turbulent flame zone was found to increase somewhat with both mass fraction burnt and engine speed. Dissert. Abstr.

**N87-29444*#** Naval Postgraduate School, Monterey, Calif.
**COMBUSTION/PARTICLE SIZING EXPERIMENTS AT THE NAVAL POSTGRADUATE SCHOOL COMBUSTION RESEARCH LABORATORY**
John Powers and David Netzer *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 135-136 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 07D

**N87-29943*#** Rochester Univ., N. Y. Dept. of Chemical Engineering.
**ELECTROCHEMICAL IMPREGNATION OF NICKEL HYDROXIDE IN POROUS ELECTRODES**
Kuo-Chuan Ho and Jacob Jorne *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 285-30 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 07D

## 26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

**N87-29637#** British Library Lending Div., Boston Spa (England).
**CALCULATING THE RAISED VISCOSITIES OF MOLTEN METALLIC ALLOYS**
Yu. A. Anikin, To Ba Van, and P. P. Arsentev 1987 5 p Transl. into ENGLISH from Iz. VUZ, (USSR), no. 11, 1986 p 146-147
(BLL-M-37230-(5828.4)) Avail: NTIS HC A02/MF A01

A more accurate method of calculating the viscosity of molten metallic alloys is presented. Instead of representing the friction function asymptotically, it is resolved into a series. By using the larger number of terms in the series the calculation is made more accurate. Viscosity is also determined more accurately by calculating it on the basis of details of the experimental oscillation cycle. Author

**N87-29638#** Argonne National Lab., Ill.
**CORROSION OF ALLOYS IN MIXED-GAS AND COMBUSTION ENVIRONMENTS**
K. Natesan May 1987 27 p Presented at the Fossil Energy Materials Program Conference, Oak Ridge, Tenn., 19 May 1987
(Contract W-31-109-eng-38)
(DE87-011452; CONF-8705103-8) Avail: NTIS HC A03/MF A01

Extensive research has been performed over the past 10 years to evaluate the compatibility of engineering materials and model alloys in oxygen-sulfur mixed-gas environments that are relevant to both coal gasification and coal combustion schemes. This paper briefly summarizes the available information to give insight into the development of protective oxide scales in high-temperature

alloys exposed to complex gas atmospheres. Results from ongoing research activities on the corrosion of high-chromium alloys are used to examine the roles of several factors such as cation and sulfur transport through the scales, mechanical effects, sulfur segregation, and time-dependent morphological changes in the scale, in the onset of breakaway corrosion in structural alloys. From current knowledge of the combustion and gasification environments and of the behavior of structural alloys exposed to them, several requirements that a suitable alloy should meet are presented, and possible avenues for modification of alloys to achieve improved corrosion resistance are discussed. DOE

**N87-29639#** Oak Ridge National Lab., Tenn.
**AEM DETERMINATION OF COMPOSITION PROFILES FORMED DURING CELLULAR PRECIPITATION IN Ni-In ALLOYS**
K. B. Alexander and D. E. Laughlin 1987 9 p Presented at the Pacific Workshop and Meeting on Analytical Electron Microscopy, Kona, Hawaii, 2 Jul. 1987 Prepared in cooperation with Carnegie-Mellon Univ., Pittsburgh, Pa.
(Contract DE-AC05-84OR-21400)
(DE87-012521; CONF-870733-5) Avail: NTIS HC A02/MF A01

Cellular precipitation occurs in a wide range of alloys and is generally associated with a degradation in mechanical and electrical properties. In order to suppress the reaction, the factors which govern the kinetics of the reaction must be understood. There have been many theories proposed to account for the growth kinetics of cellular precipitation. To compare the observed growth kinetics with any theoretical model, however, several parameters must be measured: the growth velocity, the interlamellar spacings involved and the amount of non-equilibrium segregation retained in the alpha lamellae. This last parameter has often been measured by X-ray diffraction methods. However, microanalytical techniques in the transmission electron microscope have proven to be much more informative. DOE

**N87-29640#** Oak Ridge National Lab., Tenn.
**TIME DEPENDENT COMPOSITION BEHAVIOR OF PRECIPITATES IN AGED STAINLESS STEELS**
J. M. Vitek and S. A. David 1987 20 p Presented at the Pacific Workshop and Meeting on Analytical Electron Microscopy, Kona, Hawaii, 12 Jul. 1987
(Contract DE-AC05-84OR-21400)
(DE87-012542; CONF-870733-6) Avail: NTIS HC A02/MF A01

Precipitation during aging of stainless steels is common and many studies have centered on the identification of these precipitates and the evaluation of the degree of precipitation as a function of aging time and temperature. With the availability of analytical electron microscopes (AEM), the analysis of phase stability can be furthered by the determination of the composition of individual precipitates. Such an analysis was performed on the M23C6 carbides that are found in aged type 308 stainless steel. The compositions were found to vary as a function of aging conditions. In addition, the compositions in selected cases were evaluated by several different procedures in order to evaluate some of the factors that affect the accuracy of such measurements. DOE

**N87-29641#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
**SUPERPLASTICITY**
Aug. 1987 201 p Lecture series held at Wright-Patterson AFB, Ohio, 8-9 Sep. 1987; in Luxembourg, 24-25 Sep. 1987; and in London, England, 28-29 Sep. 1987.
(AGARD-LS-154; ISBN-92-835-1557-9) Copyright Avail: NTIS HC A10/MF A01

Several topics relating to superplasticity in metals are discussed. Superplastic sheet forming, bulk forming of superplastic alloys, cavitation and superplasticity, diffusion bonding of metals, mechanical properties of superplastically formed titanium and aluminum alloys, and designing for superplastic alloys are among the topics covered. For individual titles, see N87-29642 through N87-29649.

**N87-29642#** Cranfield Inst. of Tech., Bedford (England). School of Industrial Science.
**SUPERPLASTICITY: AN OVERVIEW**
Roger Pearce *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 24 p (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

An overview is given of superplasticity. Certain alloys, when deformed in tension at particular temperatures and strain rates, show very high elongations. This phenomenon is called superplasticity. Importantly, the flow stresses at which this phenomenon occurs are extremely low. There are two kinds of superplasticity: isothermal superplasticity (ISP) and cycling superplasticity (CSP). Only the former is dealt with here. For ISP, the alloy must possess an ultra-fine grain size which is relatively stable at greater than or equal to 0.5T sub m , where T sub m is the melting point of the lowest melting constituent in the alloy, in absolute units, while for CSP the alloy must be capable of being cycled through a phase change. Stable and unstable tensile flow, the relationship of m to total elongation, production and maintenance of ultrafine grains, dynamic recovery, crystallization, and forming techniques are among the topics discussed in more detail. Author

**N87-29643#** Washington State Univ., Pullman.
**SUPERPLASTIC SHEET FORMING NATO/AGARD LECTURE SERIES ON SUPERPLASTICITY**
C. H. Hamilton *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 23 p (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

The exceptional ductility of superplastic alloys can be utilized in the shaping and forming of parts, components, and structures which could not be easily or economically produced by materials of more limited ductility. The forming methods which have been demonstrated for superplastic alloys include: blow forming, vacuum forming, thermo-forming, die-less drawing, deep drawing, forging, and superplastic forming with combined diffusion bonding. The technology of superplastic forming (SPF) has been found to benefit from modelling of the process, the results of which can guide the selection of pressurization parameters as well as predict the thinning characteristics and tendency to rupture. These concepts are reviewed. Concepts for minimizing or eliminating cavitation are also discussed. Author

**N87-29644#** Stanford Univ., Calif. Dept. of Materials Science and Engineering.
**BULK FORMING OF SUPERPLASTIC ALLOYS**
Oleg D. Sherby and Robert D. Caligiuri *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 17 p Prepared in cooperation with SRI International Corp., Menlo Park, Calif. Sponsored in part by Navy and Army (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

The commercial process of gatorizing is a prime example of a successful bulk forming process of a superplastic nickel-based alloy. In this case the one-step production of an integrated unit consisting of turbine blades with disk is achieved. This success is based on the high strain rate sensitivity inherent in superplastic materials. High strain rate sensitivity exponents, m, in crystalline solids can be achieved by one of two methods: the presence of ultra-fine grains or the presence of an internal stress. Ultra-fine grains lead to a high m value ($m = 0.5$) when the conditions of temperature and strain rate permit grain boundary sliding to be the dominating deformation process. On the other hand, internal stress, which is readily created by thermal cycling conditions in anisotropic expansion materials and in metal-matrix composites, leads to Newtonian viscous behavior ($m = 1.0$) and is attributed to a slip deformation process. Author

**N87-29645#** Manchester Univ. (England). Dept. of Metallurgy and Materials Science.
**CAVITATION AND SUPERPLASTICITY**

Norman Ridley *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 14 p (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

Cavitation occurs in many alloy systems during superplastic flow. Cavities either pre-exist or nucleate on grain boundaries and their subsequent growth, coalescence and interlinkage leads to premature failure. The presence of cavities in superplastically formed components to be used for load bearing applications is clearly undesirable. It is apparent that cavity growth is dominated by matrix plastic flow and that coalescence plays an important role in the development of large cavities. If cavitation damage is to be prevented, it is necessary to inhibit the nucleation event and to avoid the presence of pre-existing defects by careful control of the processing required to produce the superplastic microstructure. The influence that microstructural features and deformation conditions have on cavity nucleation is examined for a number of alloy systems. Cavitation can be eliminated by the application of a hydrostatic pressure during forming. This reverses the sense of the driving force for cavity growth. Cavitation damage can be prevented by superimposed pressures of 0.5 and 0.75 of the uniaxial flow stress, although lower levels of pressure can substantially reduce the extent of cavitation. Author

**N87-29646#** Royal Aircraft Establishment, Farnborough (England). Materials and Structures Dept.
**DIFFUSION BONDING OF METALS** **c37**
P. G. Partridge *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 23 p (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

The need to reduce the cost and weight of aerospace metallic structures has led to an increased interest in solid state and liquid phase diffusion bonding processes, especially in combination with superplastic forming. The bonding mechanisms and bonding techniques are reviewed and the process variables that affect bond quality and strength are described with reference to bonds between Ti-alloys, Al-alloys and dissimilar metals. The importance of quality control and the limitations of current nondestructive evaluation techniques for diffusion bonding are emphasized. Finally, some trends and priorities in diffusion bonding technology are indicated. Author

**N87-29647#** Royal Aircraft Establishment, Farnborough (England).
**THE MECHANICAL PROPERTIES OF SUPERPLASTICALLY FORMED TITANIUM AND ALUMINIUM ALLOYS**
P. G. Partridge, D. S. McDarmaid, I. Bottomley, and D. Common *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 23 p (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

The behavior of aluminum and titanium alloys under superplastic forming conditions is well documented but there is less published data on the effect of the superplastic forming process on the mechanical properties. These data are essential for the design of structures. The effect of superplastic forming parameters such as temperature, strain rate, strain and post forming heat treatments upon the tensile, fatigue and fatigue crack growth performance of these alloys is reviewed and the mechanical property variations are related to changes in microstructure. During superplastic forming of aluminum alloys, intergranular cavities are formed with increasing strain, which degrades the material and reduces the mechanical properties. Ways to prevent cavitation during and after superplastic forming have been developed and the effect of these treatments on the mechanical properties is discussed. Author

**N87-29648#** British Aerospace Public Ltd. Co., Bristol (England). Production Improvements.
**DESIGNING FOR SUPERPLASTIC ALLOYS** **c31**
D. Stephen *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 37 p (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

Substantial evidence exists to support the claim that titanium alloys, when processed by the superplastically formed (SPF) diffusion bonded (DB) route, can compete in weight and more particularly cost, with conventional aluminum fabrication. This is likely to be a major factor in the future exploitation of these processes and clearly requires a revision to the designers traditional views of the areas of application for titanium alloys. However, the development of a combined SPF/DB process for aluminum alloys, with the full range of capabilities provided currently by titanium alloys, remains to be established. Author

**N87-29649#** Alcan International Ltd., London (England).
**THE MANUFACTURE OF SUPERPLASTIC ALLOYS** **c31**
R. Grimes *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 16 p (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

Amongst aluminum alloys, the Al-6 percent Cu-0.4 percent Zr system that typifies the Supral alloys requires a specially developed casting system in order to achieve a very high level of supersaturation with zirconium. Subsequent manufacturing is fairly conventional, the sheet product recrystallizing dynamically during superplastic forming. The higher strength aluminum alloys are conventionally cast but achieve a very fine grain size at sheet stage by careful thermal mechanical treatment during the later stages of semi-fabrication. With titanium, the standard production route for the Ti-6Al-4V alloy results in a product with superplastic capabilities perfectly adequate for most applications. Author

**N87-29650*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**ELEVATED TEMPERATURE ALUMINUM ALLOYS Patent Application**
Peter Meschter, inventor (to NASA), Richard J. Lederich, inventor (to NASA), and James E. ONeal, inventor (to NASA) (McDonnell-Douglas Corp., St. Louis, Mo.) 30 Jul. 1987 12 p
(NASA-Case-LAR-13632-1; NAS 1.71:LAR-13632-1; US-Patent-Appl-SN-079316) Avail: NTIS HC A02/MF A01
CSCL 11F

Three aluminum-lithium alloys are provided for high performance aircraft structures and engines. All three alloys contain 3 wt% copper, 2 wt% lithium, 1 wt% magnesium, and 0.2 wt% zirconium. Alloy 1 has no further alloying elements. Alloy 2 has the addition of 1 wt% iron and 1 wt% nickel. Alloy 3 has the addition of 1.6 wt% chromium to the shared alloy composition of the three alloys. The balance of the three alloys, except for incidental impurities, is aluminum. These alloys have low densities and improved strengths at temperatures up to 260 C for long periods of time. NASA

**N87-29651#** Sandia National Labs., Albuquerque, N. Mex.
**MEASUREMENT OF TRANSFORMATION KINETICS IN NI-B METASTABLE CRYSTALLINE AND AMORPHOUS ALLOYS BY DSC**
E. P. Roth, A. N. Campbell, and A. W. Mullendore 1987 12 p Presented at the 16th Annual Conference of the North American Thermal Analysis Society, Washington, D.C., 27 Sep. 1987
(Contract DE-AC04-76DP-00789)
(DE87-010953; SAND-87-0591C; CONF-870988-1) Avail: NTIS HC A02/MF A01

Chemical vapor deposition (CVD) has been used to prepare amorphous and polycrystalline films of Ni-B from nickel carbonyl and diborane at 155 C. Three low-boron content samples containing 2.6, 5.3, and 13.0 at. percent boron were prepared which had a fine-grained polycrystalline structure of fcc nickel supersaturated with boron. A high-boron content sample was prepared containing 37 at. percent boron and was completely amorphous. Upon heating above 300 C, Ni3B precipitates from the polycrystalline low-boron content samples, while Ni2B and Ni4B3 forms from the high-boron content sample near 500 C. While the mechanical properties of some of these alloys are enhanced during the initial stages of transformation, the coarsening of the microstructure during extensive annealing is accompanied by a decrease in strength and hardness. A DSC study of the Ni-B alloys was undertaken to

assess the thermal stability of the as-deposited microstructure. The enthalpies and kinetics of intermetallic formation were studied with both constant-heating-rate (CHR) and isothermal measurement techniques. DOE

**N87-29652#** California Univ., Berkeley.
**MASS TRANSPORT AND POTENTIAL DISTRIBUTION IN THE GEOMETRIES OF LOCALIZED CORROSION**
J. Newman 24 Jun. 1987 42 p Presented at the International Conference on Localized Corrosion, Orlando, Fla., 1 Jun. 1987
(Contract DE-AC03-76SF-00098)
(DE87-012819; LBL-23474; CONF-870658-1) Avail: NTIS HC A03/MF A01

Localized corrosion, such as pitting, crevice, and water-line corrosion, necessarily involves a passivating metal - one for which an increase in the local electrode potential results in a decrease in the dissolution current. In this situation, the anodic and the cathodic reactions occur in different locations. Consequently, transport of charge and material species in the solution is involved in processes of localized corrosion. Here fundamental aspects of mass transfer and potential distribution are reviewed with an eye toward applications in localized corrosion. Recent work on passivation, salt-film formation, and oscillatory behavior on iron in 1 M sulfuric acid is reviewed as well as modeling efforts on the partly active, partly passive corrosion of rotating iron disks in sea water. DOE

**N87-29653#** Sandia National Labs., Albuquerque, N. Mex.
**HETEROGENEOUS DEFORMATION MODEL FOR THE HIGH PRESSURE STRENGTH OF ALUMINUM**
J. W. Swegle 1987 6 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-011063; SAND-87-0774C; CONF-870753-38) Avail: NTIS HC A02

Recent data from a series of reshock and unloading experiments on 6061-T6 aluminum have provided values of both yield strength and deviatoric stress in the initial shocked state. The data indicate that the stress state lies inside the yield surface after passage of the first shock wave. This is also supported by the appearance of an elastic precursor with the second shock in the reshock experiments. Standard elastic-plastic theories are unable to predict this anomalous behavior and postulated mechanisms have involved high temperature transients in regions associated with shear banding. Heat conduction normally occurs on time scales which are long compared to shock risetimes, but shear bands are so thin that they can be expected to thermally equilibrate with surrounding material in times comparable to shock risetimes. However, shock risetimes have been found to be a strong function of shock stress, and this effect must be included along with heat conduction in order to correctly calculate shear band temperatures. A recently developed viscous model provides correct shock wave risetimes in finite-difference wavecode calculations and has thus allowed the first capability for modeling the phenomenon of thermal trapping in shear bands. At low stresses, risetimes are long compared to thermal diffusion times and shear bands stay in thermal equilibrium with surrounding material, but at high stresses risetimes are very short, and shear band temperatures greatly exceed bulk temperatures before thermal equilibrium occurs. Decreasing yield strength with increasing shear band temperature followed by yield strength recovery due to thermal quenching as the shear bands cool produces good agreement with the experimental data on aluminum. DOE

**N87-29654#** California Univ., Berkeley. Lawrence Berkeley Lab.
**STRAIN CONTROLLED MORPHOLOGIES IN THE TWO-PHASE STATE**
A. G. Khachaturyan Jun. 1987 48 p Presented at the NATO Advanced Study Institute on Alloy Phase Stability, Crete, Greece, 14 Jun. 1987
(Contract DE-AC03-76SF-00098)
(DE87-012888; LBL-23535; CONF-8706103-4) Avail: NTIS HC A03/MF A01

The main topic of this lecture is the discussion of the application of the elastic theory to practical problems which arise in structural studies of the morphology of two-phase alloys. The consideration is based on the theory developed for the homogeneous modulus case because this approach enables one to treat arbitrary dispersoids using very simple mathematics. The cases where this approximation turns out to be insufficient are discussed. The applied aspects of the theory are especially emphasized. There are three groups of problems discussed in detail: morphology of a single coherent precipitate, its habit plane, equilibrium shape, orientational relations and crystal lattice parameters in the constraint state; shape transformations and morphology instabilities upon coarsening; and strain-induced rearrangement of groups of precipitates upon coarsening. DOE

**N87-29655#** Sandia National Labs., Albuquerque, N. Mex.
**SHOCK-INDUCED VAPORIZATION OF POROUS ALUMINUM**
G. I. Kerley and J. L. Wise 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012978; SAND-87-0886C; CONF-870753-42) Avail: NTIS HC A02/MF A01

The expansion behavior of hot fluid aluminum was studied by shock-induced vaporization. Thin plates of porous aluminum (rho approx. = 1.6 Mg/cu m) were shocked to pressures of about 80 GPa, sufficient to produce vaporization upon release, then allowed to expand across a gap. The velocity time history produced by stagnation of the expansion products against a witness plate was measured using an interferometer. The experimental data were compared to one-dimensional wavecode calculations to evaluate the aluminum equation of state. A principal aim of this work was to test a theoretical prediction of a plasma phase transition in the hot expanded metal. However, the results do not provide any evidence for the existence of this transition. DOE

**N87-29656#** North Carolina State Univ., Raleigh.
**MODELING OF CHEMICAL REACTIONS IN THE MIXTURE OF Al-Ni POWDERS UNDER SHOCK-WAVE COMPRESSION**
Y. Horie and M. E. Kipp Jul. 1987 4 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987 Prepared in cooperation with Sandia National Labs., Albuquerque, N. Mex.
(Contract DE-AC04-76DP-00789)
(DE87-012979; SAND-87-1871C; CONF-870753-41) Avail: NTIS HC A02/MF A01

Based upon microstructural observations of post-shock samples, a mathematical model was developed for chemical changes in the mixture of elemental Al and Ni powders from the passage of high-pressure shock-waves. The model was solved and illustrated using the one-dimensional Sandia code WONDY-IV. DOE

**N87-29657#** Los Alamos National Lab., N. Mex.
**USING RAPID SOLIDIFICATION PROCESSING TO PRODUCE MICROSTRUCTURES WITH OPTIMUM PROPERTIES**
P. L. Martin and J. C. Williams 1986 11 p Presented at the 4th Rapid Solidification Conference, Santa Barbara, Calif., 14 Dec. 1986 Prepared in cooperation with Carnegie-Mellon Univ., Pittsburgh, Pa.
(Contract W-7405-eng-36)
(DE87-013161; LA-UR-87-2449; CONF-861257-2) Avail: NTIS HC A02/MF A01

Rapid Solidification Processing (RSP) permits an additional degree of freedom for tailoring the microstructure of materials. As a result, microstructures can be controlled to a degree which has not been consistently achieved by ingot metallurgy methods. This capability provides an opportunity to optimize a particular property or set of properties. When the choices of microstructure are

required to make up front, it turns out that the bases for making them are often not well-founded in fundamentals. In this paper we review the principles for selecting microstructures and attempt to identify those areas where our understanding is incomplete. We also discuss some cases where these microstructural choices can be made and some where they cannot. Further, we describe some specific examples of alloy systems where RSP has been used successfully to tailor properties. Finally, we attempt to assess the potential for extending these techniques to other alloy systems and to define some of the current limitations which are associated with RSP. This discussion permits identification of those areas where additional research on processing-microstructure and microstructure-property relations is indicated. DOE

**N87-29658#** Technical Research Centre of Finland, Espoo. Metals Lab.

**THE EFFECT OF IRON ON THE ELECTROCHEMICAL PROPERTIES OF TITANIUM IN SEA WATER**

Kari Saarinen Jan. 1987 57 p In FINNISH; ENGLISH summary Sponsored by the Federation of Finnish Metal and Engineering Industries

(VTT-462; ISBN-951-38-2781-X; ISSN-0358-5077; ETN-87-90057) Copyright Avail: NTIS HC A04/MF A01; Technical Research Centre of Finland, Espoo, Finland FIM 58

The microstructure of iron-alloy titanium was studied using optical microscopy and scanning electron microscopy (SEM). The corrosion potentials of the different titanium-iron alloys were measured at room temperature in the active and passive state. Crack-corrosion samples and stressed double-V bars were also studied at elevated temperatures. The microstructural change from single-phase alpha Ti to two-phase alpha + beta Ti with growing solid solution iron content is evident. The electrochemical measurement curves of titanium in a sea water environment reveal a wide passive part. Solid solution iron influences the corrosion potential and current, diminishing the corrosion resistance. Corroded iron particles cause pitting of the titanium surface at elevated temperatures. Sufficient amounts of Fe (3+) ions may passivate a corroding titanium surface. ESA

**N87-29659#** Kernforschungsanlage, Juelich (West Germany). Inst. fuer Festkoerperforschung.

**HYDROGEN AND DEUTERIUM IN VANADIUM AS INTERESTING LATTICE GASES Ph.D. Thesis - Technische Hochschule [WASSERSTOFF UND DEUTERIUM IN VANADIUM ALS WECHSELWIRKENDE GITTERGASE]**

Paul Meuffels Aug. 1986 146 p In GERMAN; ENGLISH summary

(JUEL-2081; ISSN-0366-0885; ETN-87-90341) Avail: NTIS HC A07/MF A01

The thermodynamic characteristics of the systems V-H and V-D were examined using lattice gas models. Pressure-composition isotherms (150 to 550 C) for solutions of H and D in V, and the temperature dependence of the heat capacity in V-D alloys were determined in the V-H(D) phase diagrams. The concentration dependence of the partial molar enthalpies and entropies of H and D were derived from solubility data. The heat capacity of V-D contains a substantial excess contribution which remains when estimated electronic and vibrational contributions are subtracted from the experimental data. The experimental results were analyzed by Monte Carlo simulations of a lattice gas with repulsive short range interactions between H(D) atoms. The essential features of the experimental results are described by a lattice gas model including hard core interactions and finite repulsive interactions outside the hard core. ESA

**N87-29660#** Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Material- und Festkoerperforschung.

**DETERMINATION OF THE CREEP MECHANISMS OF THE SNR STRUCTURAL MATERIAL X6rNi 1811 (DIN 1.4948) FROM MICROSTRUCTURAL INVESTIGATIONS**

R. Gross and B. Bennek-Kammerichs Jan. 1987 84 p In GERMAN; ENGLISH summary

(KfK-4086; ISSN-0303-4003; ETN-87-90346) Copyright Avail: NTIS HC A05/MF A01

The structural variations at the grain boundaries in broken creep specimens of stainless steel X6CrMi 1811 were metallographically studied. Using the data of mechanical creep tests, in relation with the metallographic results, the different temperature and stress dependent creep mechanisms were revealed. The transformation of grain boundary carbides to particles of the sigma phase was elucidated in correlation with grain boundary gliding. The extrapolation of creep properties to stresses and temperatures below those in the tests is problematic due to the stress and temperature dependent structural changes. ESA

**N87-29661#** Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Nukleare Festkoerperphysik.

**LATTICE SITE OCCUPATION OF INSOLUBLE IMPURITY ATOMS IN ALUMINIUM AFTER IMPLANTATION AND IRRADIATION Thesis - Karlsruhe Univ.**

M. K. Kloska Mar. 1987 176 p In GERMAN; ENGLISH summary

(KfK-4206; ISSN-0303-4003; ETN-87-90350) Copyright Avail: NTIS HC A09/MF A01

The lattice site occupation and substitutional fraction of insoluble impurity atoms, implanted in aluminum single crystals at several temperatures, was investigated using the ion-channeling technique. The substitional fractions, obtained by in situ analyses, strongly depend on the implantation temperature. The nonsubstitutional component consists of impurity atom-vacancy complexes, formed in the coding phase of the cascade. The part of the impurity atom-vacancy complexes which is formed additionally above the temperature of stage three can be completely recovered by postirradiation with ions of different masses at low temperatures. The increase of the substitutional fraction is independent of the impurity atom concentration, cascade density, mean transfered energy, and damage production efficiency. The results constitute an experimental confirmation of molecular dynamics calculations of the cascade evolution. ESA

**N87-29662*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**HIGH TEMPERATURE RADIATOR MATERIALS FOR APPLICATIONS IN THE LOW EARTH ORBITAL ENVIRONMENT**

Sharon K. Rutledge, Bruce A. Banks, Michael J. Mirtich, Richard Lebed, Joyce Brady, Deborah Hotes, and Michael Kussmaul (Cleveland State Univ., Ohio.) 1987 19 p Presented at the 1987 Spring Meeting of the Materials Research Society, Anaheim, Calif., 20-24 Apr. 1987

(NASA-TM-100190; E-3772; NAS 1.15:100190) Avail: NTIS HC A02/MF A01 CSCL 11F

Radiators must be constructed of materials which have high emittance in order to efficiently radiate heat from high temperature space power systems. In addition, if these radiators are to be used for applications in the low Earth orbital environment, they must not be detrimentally affected by exposure to atomic oxygen. Four materials selected as candidate radiator materials (304 stainless steel, copper, titanium-6% aluminum-4% vanadium (Ti-6%Al-4%V), and niobium-1% zirconium (Nb-1%Zr)) were surface modified by acid etching, heat treating, abrading, sputter texturing, electrochemical etching, and combinations of the above in order to improve their emittance. Combination treatment techniques with heat treating as the second treatment provided about a factor of two improvement in emittance for 304 stainless steel, Ti-6%Al-4%V, and Nb-1%Zr. A factor of three improvement in emittance occurred for discharge chamber sputter textured copper. Exposure to atomic oxygen in an RF plasma asher did not significantly change the emittance of those samples that had been heat treated as part of their texturing process. An evaluation of oxygen penetration is needed to understand how oxidation affects the mechanical properties of these materials when heat treated. Author

**N87-29663#** California Univ., Berkeley. Lawrence Berkeley Lab.
**ACID-BASE REACTIONS OF TRANSITION METAL ALLOYS: THERMOCHEMISTRY OF THE BASE-RICH END Ph.D. Thesis**
Joseph Henry Bularzik Jun. 1987 135 p
(Contract DE-AC03-76SF-00098)
(DE87-012817; LBL-23665) Avail: NTIS HC A07/MF A01

The thermodynamics of binary transition metal alloys, stabilized by generalized Lewis acid-base reactions, were studied within the context of the Engel-Brewer Theory. The activity of the base metal was determined from the vapor pressure measurements of the Pd or Rh in the base-rich end of TiPd, VPd, Nbpd, and Rm alloys. The vapor pressures were determined by thermally induced atomic emission spectroscopy. The composition of the alloys in equilibrium with carbon were determined. From the known thermodynamics of the metal carbines, the activity was calculated for the acid metals. Titration curves from the pure base metal to the compositions in equilibrium with carbon were developed. The data confirmed the general qualitative properties of the acid-base reaction. The 4d metals are better acids than the 3d metals. The effeciveness of the acid-base reaction across a transition series is determined by the number of d electron pairs available for donation, the number of empty d orbitals available to accept electron pairs, the nuclear charge, and a crystal field effect. The data was compared to the regular solution model in an attempt to represent the solution behavior. GRA

**N87-29664#** Rensselaer Polytechnic Inst., Troy, N.Y.
**DISPERSION STRENGTHENING Final Report**
George S. Ansell, Gary Judd, and C. Tomonto 27 Jul. 1987 27 p
(Contracts N00014-76-C-0458; N00014-85-K-0058)
(AD-A183318) Avail: NTIS HC A03/MF A01 CSCL 11F

The purpose of this program was to develop a fundamental understanding of the role of finely dispersed second phase particles on the properties of crystalline solids. Considering that the addition of a dispersed second phase is a common strengthening method, it is surprising to note the lack of information concerning the role of the dispersed second phase on physical and mechanical properties in two phase structures, e.g., heterogeneous nucleation kinetics and phase transformations. The goal of this research program was to enhance the application and development of high strength engineering alloys through achieving a better understanding of the role of dispersed second phases. The scope of this work has been directed towards studying the strengthening behavior of nickel-base superalloys, the strengthening behavior of ferrous martensite, and the kinetics of the austenite to martensite transformation. These studies have focused on the fundamental aspects of these two-phase systems that appear to control the structural characteristics and the mechanical response of these important classes of engineering materials. The following sections will describe the significant results determined. GRA

**N87-29665#** Rensselaer Polytechnic Inst., Troy, N.Y. Dept. of Materials Engineering.
**THE INFLUENCE OF DESORPTION KINETICS ON HYDROGEN PERMEATION IN IRON Interim Report**
M. Arbab and J. B. Hudson 30 Jul. 1987 41 p
(Contract N00014-86-K-0259)
(AD-A183356; TR-1) Avail: NTIS HC A03/MF A01 CSCL 07D

The common observation that the diffusivity of hydrogen in iron decreases anomalously at low temperatures is treated in terms of the barrier to atom recombination and desorption that is known to be associated with the surfaces of this metal. Results obtained are in good agreement with both data on deuterium permeation through a polycrystalline iron sample, obtained in this study, and with the body of measurements for hydrogen diffusion through iron found in the literature. GRA

**N87-29666#** Army Armament Research, Development and Engineering Center, Picatinny Arsenal, N.J. Product Assurance Directorate.
**WATER SOLUBLE CORROSION INHIBITORS TO PROTECT IMMERSED STEEL AND ALUMINUM Final Report**
Henry Hartmann Jul. 1987 18 p
(AD-A183457; ARPAD-MR-87001) Avail: NTIS HC A02/MF A01 CSCL 11F

The water in tanks used for ultrasonic tests needs a corrosion inhibitor to protect immersed steel and aluminum metal parts. Very dilute concentrations of sodium nitrite and silicon dioxide (the active ingredient of sodium silicate) separately provide complete corrosion protection for at least three days. GRA

**N87-29667#** Pennsylvania State Univ., University Park. Dept. of Materials Science and Engineering.
**ADVANCED PROCESSING AND PROPERTIES OF HIGH PERFORMANCE ALLOYS Technical Report, 1 May 1986 - 31 Jan. 1987**
D. A. Koss Feb. 1987 41 p
(Contract N00014-86-K-0381)
(AD-A183566; TR-6) Avail: NTIS HC A03/MF A01 CSCL 11F

Progress is reviewed for a research program whose purpose is to establish a broad-based understanding of the application and consequences of advanced processing techniques, especially as they influence the strength and fracture resistance of high performance structural alloys. While some of the research is specific to certain alloy systems, many aspects of the program constitute fundamental studies of the deformation and fracture of engineering alloys containing processing-indiced defects. Progress for the period May 1, 1986 to January 31, 1987 is reviewed for the following projects within program: (1) the mechanism of void/pore linking in ductile fracture; (2) the influence of porosity on low cycle fatigue; (3) the deformation of rapidly solidified Ti alloys at elevated temperatures; (4) strain-path effects on fracture; and (5) hot isostatic pressing of metallic powders. GRA

# 27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

**N87-29668*#** Lehigh Univ., Bethlehem, Pa. Emulsion Polymers Inst.
**EVALUATION OF ROTATING-CYLINDER AND PISTON-CYLINDER REACTORS FOR GROUND-BASED EMULSION POLYMERIZATION Quarterly Progress Report, 20 May - 19 Aug. 1987**
J. W. Vanderhoff and M. S. El-Aasser 1987 11 p
(Contract NAS8-36286)
(NASA-CR-179179; NAS 1.26:179179) Avail: NTIS HC A02/MF A01 CSCL 11B

The objectives of this program are to apply ground-based emulsion polymerization reactor technology to improve the production of: monodisperse latex particles for calibration standards, chromatographic separation column packing, and medical research; and commercial latexes such as those used for coatings, foams, and adhesives. Author

**N87-29669#** Oak Ridge National Lab., Tenn.
**TESTING OF DEVELOPMENTAL CERAMIC MATERIALS IN DIESEL ENGINE COMBUSTION CHAMBERS**
R. L. Graves, W. K. Kahl, and E. L. Long, Jr. 1987 8 p
Presented at the 10th Energy Sources Technology Conference and Exhibition, Dallas, Tex., 15 Feb. 1987
(Contract DE-AC05-84OR-21400)
(DE87-004259; CONF-870210-1) Avail: NTIS HC A02

The development of the adiabatic (i.e., low-heat-rejection) diesel is unique in that it affords opportunities to improve the fuel efficiency

of transportation power plants and to utilize lower-quality fuels as well. Achievement of the adiabatic diesel involves the use of high-temperature-resistant, thermally insulating materials in the construction of the combustion chamber. These materials, in the form of coatings or monolithic components, may have to operate at nominal surface temperatures of 1000°C. Promising new materials, several under development at ORNL, have not yet been subjected to dynamic engine conditions to aid in determining their feasibility for combustion chamber applications. A testing project at ORNL is seeking to fill in the information gap between materials development in the laboratory and full-fledged component development. An initial set of simply configured ceramic samples were tested in a single-cylinder 0.825-liter diesel engine. The composite ceramic samples were all made from the same material, composed of an alumina (Al2O3) matrix with silicon carbide (SiC) whiskers. A sample of partially stabilized zirconia (PSZ) was also tested to provide a monolithic material baseline. The samples were mechanically held inside the prechamber of this indirect-injection diesel in a position and configuration resembling the normal glow-plug. They were subjected to individual repetition periods of the same basic hour-long test cycle involving three load changes. Although direct measurement of internal material temperatures was not performed, thermocouple probes indicated peak ceramic bulk temperatures of approx. 650 EC were approached. One of the samples failed catastrophically for uncertain reasons. Microscopic examination of the tested samples generally revealed no significant changes in the composite material's matrix/whisker microstructure. DOE

**N87-29670#** Bendix Corp., Kansas City, Kans.
**CHARACTERIZATION OF DEFECTS IN Mn-Zn FERRITES BY SCANNING LASER ACOUSTIC MICROSCOPY (SLAM)**
C. W. Boehning and W. D. Tuohig Jun. 1987 13 p Presented at the 16th International Symposium on Acoustic Imaging, Chicago, Ill., 10 Jun. 1987
(Contract DE-AC04-76DP-00613)
(DE87-010677; BDX-613-3700; CONF-8706116-1) Avail: NTIS HC A02/MF A01

A scanning laser acoustic microscope (SLAM) has been used to evaluate the integrity of Mn-Zn ferrite ceramic components which comprise part of the magnetic circuit in an electromechanical code interrogation device. Cracking of the ferrites during processing and assembly emerged as a significant manufacturing problem. Operations such as grinding, metallization, joining, and welding were suspected of causing damage, and acoustic microscopy was used to monitor these processes. Parts which produced suspicious acoustic images were dismantled and destructively sectioned to identify specific physical defects. Correlations between the defects and their acoustic signatures were established. This procedure has provided the basis for several process modifications and improvements which have resulted in acceptable production yields. The SLAM is used as an engineering tool for the detection and characterization of defects and is presently being used routinely to inspect production ferrite components. DOE

**N87-29671#** Oak Ridge National Lab., Tenn.
**CERAMIC-FIBER CERAMIC-MATRIX HOT-GAS FILTERS**
D. P. Stinton and R. Chang Jun. 1987 16 p Presented at the 7th Annual Gasification Systems Conference, Morgantown, W. Va., 16 Jun. 1987 Prepared in cooperation with Acurex Corp., Mountain View, Calif.
(Contract DE-AC05-84OR-21400)
(DE87-012538; CONF-870659-3) Avail: NTIS HC A02/MF A01

This program is currently developing a process for the fabrication of ceramic composite filter specimens by chemical vapor deposition. A process for the fabrication of dense ceramic composites is being modified to produce low density filter specimens. The process modifications include elimination of the thermal gradient across the fibrous preform and the control of the porosity distribution to produce a composite suitable for high-temperature filter applications. The configuration of the filter specimens (fiber composition and porosity distribution, composition of deposited material, filter design, etc.) will be investigated to optimize filter efficiency, cleanability, strength, toughness, and chemical compatibility. Filter specimens of the optimum configuration will then be fabricated in tubular shapes for candle filter applications. Corrugated fabrics will be utilized to increase the available surface area of the candle filter. DOE

**N87-29672*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**TAPERED, TUBULAR POLYESTER FABRIC Patent Application**
Donat J. E. LaPointe, inventor (to NASA), Lawrence T. Wright, inventor (to NASA), and Laurence J. Vincent, inventor (to NASA) (Albany International Corp., Dedham, Mass.) 30 Jul. 1987 12 p
(NASA-Case-MSC-21082-1; NAS 1.71:MSC-21082-1; US-Patent-Appl-SN-079320) Avail: NTIS HC A02/MF A01 CSCL 11E

A tapered tubular polyester sleeve is described to serve as the flexible foundation for a spacesuit limb covering. The tube has a large end and a small end with a length to be determined. The ratio of taper is also determined by scale factors. All the warp yarns extend to the large end. A requisite number of warp yarns extend the full length of the sleeve. Other warp yarns extend from the large end but are terminated along the length of the sleeve. It is then woven with a filling yarn which extends in a full circle along the full length of the sleeve to thereby define the tapered sleeve. The sleeve after fabrication is then placed on a mandrel, heated in an oven, and then attached to the arm or other limb of the spacesuit. NASA

**N87-29673#** Argonne National Lab., Ill.
**DEVELOPMENT OF ADVANCED NONDESTRUCTIVE EVALUATION METHODS FOR CERAMIC PROCESSING RELIABILITY**
W. A. Ellingson, J. L. Ackerman, B. D. Sawicka, R. A. Roberts, and R. B. Poeppel Mar. 1987 7 p Presented at the Processing for Reliability of Advanced Ceramics, Corning, N.Y., 21 Oct. 1986 Prepared in cooperation with Massachusetts General Hospital, Boston; Atomic Energy of Canada LTD., Chalk River, Ontario. Chalk River Nuclear Labs.
(Contract W-31109-eng-38)
(DE87-012216; CONF-8610299-1-Ext-Abst) Avail: NTIS HC A02/MF A01

Functional failure of parts or components fabricated from ceramics is most often traced to defects (e.g., inclusions, undesirable density gradients, cracks, poor binder/plasticizer distributions, etc.) introduced in the early processing steps. Detection of these defects, especially in the green state, and elimination of the source of these defects will improve the economics as well as the reliability of advanced ceramics. DOE

**N87-29674#** Wisconsin Univ., Madison.
**ORDERED CERAMIC MEMBRANES Annual Progress Report: Feb. 1986 - Mar. 1987**
M. A. Anderson and C. G. Hill, Jr. Jun. 1987 63 p
(Contract DE-AS07-86ID-12626)
(DE87-012714; DOE/ID-12626/T1) Avail: NTIS HC A04/MF A01

Effort has focused on the solution variables that ultimately control the characteristics of the precursor sols, gels, and the ceramic membranes. We have succeeded in producing crack-free Al2O3 and TiO2 unsupported ceramic membranes. The Al2O3 membranes are particulate whereas we have been preparing both polymeric and particulate TiO2 unsupported membranes. These membranes have pore diameters in the 20 to 50 A range. Major variables in both cases include the alkoxide/water ratio and the initial time and temperature of the reaction. Ionic strength seems to be of lesser importance. Sintering conditions are also important in controlling the pore size. The TiO2 membranes supported by glass substrates are photoactive and capable of degrading polychlorinated biphenyls in aqueous solution when exposed to uv irradiation. We have also been experimenting with two types of supporting materials for producing ceramic filters. Both clay and alumina precursors have yielded supports that had sufficient

strength and porosity to be candidates for membrane supports.
DOE

**N87-29675#** Oak Ridge National Lab., Tenn.
**ION IMPLANTATION AND ANNEALING OF CRYSTALLINE OXIDES AND CERAMIC MATERIALS**
C. W. White, L. A. Boatner, P. S. Sklad, C. J. McHargue, J. Rankin, G. C. Farlow, and M. J. Aziz May 1987 37 p Presented at the Radiation Effects in Insulators-4 Conference, Lyon, France, 6 Jul. 1987
(Contract DE-AC05-84OR-21400)
(DE87-012290; CONF-870783-1) Avail: NTIS HC A03/MF A01

The response of several crystalline oxides or ceramic materials to ion implantation and subsequent thermal annealing is described. For both SrTiO3 and CaTiO3 single crystals, the near-surface region can be turned amorphous by relaiively low doses of heavy ions. During annealing, the amorphous region recrystallizes epitaxially with the underlying substrate by simple solid-phase epitaxy, and the crystallization kinetics have been determined for both of these materials. In Al2O3, the amorphous phase of the pure material is produced by a stoichiometric implant at liquid nitrogen temperature. During annealing, the amorphous film crystallizes in the (crystalline) gamma phase, followed by the transformation of the gamma to the alpha phase at a well-defined interface. The kinetics characterizing the growth of alpha-Al2O3 have been determined. Preliminary results are presented on the effect of impurities (Fe) on the nature and kinetics of the crystallization of amorphous Al2O3.
DOE

**N87-29676#** Pennsylvania Univ., Philadelphia. Dept. of Materials Science.
**LOW STRESS BRITTLE FRACTURE IN POLYMERS Annual Technical Progress Report**
N. Brown 13 Jul. 1987 5 p
(Contract DE-FG02-84ER-45161)
(DE87-012823; DOE/ER-45161/3) Avail: NTIS HC A02/MF A01

A comparative investigation was made on the difference in slow crack growth behavior of a linear polyethylene and an ethylene-hexene co-polymer with 4.8 butyle branches per 1000 carbon atoms. Whereas the kinetics of initiation were linear in time, for the linear PE they were logarithmic for the copolymer; whereas a critical COD governs the beginning of crack growth in linear PE, the incubation time for crack growth in the co-polymer is about 0.6 of the time for complete failure. The difference between the morphologies of these materials fitted the observed difference in kinetic behavior. Based on the kinetics of damage initiation for ductile failure and brittle failure by slow crack growth, equations were developed for determining the critical time and stress for the ductile-brittle transition at a given defect and temperature.
DOE

**N87-29677#** Kernforschungsanlage, Juelich (West Germany). Inst. fuer Reaktorwerkstoffe.
**CHARACTERISTIC STRENGTH VALUES FOR THE SAFETY-ENGINEERING DESIGN OF CERAMIC COMPONENTS IN ENERGY GENERATING PLANTS**
F. E. Buresch and W. Meyer / Dec. 1986 113 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie, Bundesminister des Inneren, and Minister fuer Wirtschaft, Mittelstand und Verkehr
(JUEL-2102; ISSN-0366-0885; ETN-87-90344) Avail: NTIS HC A06/MF A01

Transfer of strength characteristics between samples and from samples to components for uniaxial loading was studied, using probability fracture mechanics taking into account the volume effect. Microcracks were evaluated in highly stressed regions of microstructural heterogeneities or design notches. Experiment shows that small density fluctuations cause multimodal strength distributions which are related to changes of fracture mechanisms. Multimodal strength distributions were separated in unimodal Weibull distributions using physical and statistical methods. Within each materials variation, bend and tensile strength data can be converted into one another with respect to the stress volume integral. Lifetime predictions hold only for a specific microstructure.
ESA

**N87-29678*#** National Aeronautics and Space Administration, Washington, D.C.
**JOINING OF CERAMICS FOR HIGH TEMPERATURE APPLICATIONS**
Martti Vilpas Oct. 1987 28 p Transl. into ENGLISH of Korkeissa Lampotiloissa Kaytettavien Keraamisten Materiaalien Liittaminen, (Espoo, Finland), Aug. 1985 p 1-37 Original language document was announced as N86-30878 Transl. by SCITRAN, Inc., Santa Barbara, Calif. Original document prepared by Technical Research Center of Finland, Espoo
(Contract NASw-4004)
(NASA-TT-20030; NAS 1.77:20030; VTT-TIED-481) Avail: NTIS HC A03/MF A01 CSCL 11B

Summarized is a literature survey of the methods for joining ceramics to ceramics or ceramics to metals for high temperature applications. Also mechanical properties and potential applications of the joints are considered. The joining of ceramics is usually carried out by brazing or diffusion bonding. Especially the latter has been found useful, increasing the application of bonded ceramics. The possibility of using electron beam and laser beam welding for joining ceramics has also recently been investigated. The bonding of ceramics has found numerous applications typical for high operating temperatures, i.e., sensors and thermocouples.
Author

**N87-29679*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**COMPARISON OF THE TRIBOLOGICAL PROPERTIES OF FLUORINATED COKES AND GRAPHITES**
Robert L. Fusaro [1987] 32 p Proposed for presentation at the 1988 Annual Meeting of the Society of Tribologists and Lubrication Engineers, Cleveland, Ohio, 9-12 May 1988
(NASA-TM-100170; E-3735; NAS 1.15:100170) Avail: NTIS HC A03/MF A01 CSCL 11B

The friction, wear, endurance life, and surface morphology of rubbed (burnished) fluorinated graphite and fluorinated coke materials were studied. Two different coke powders, a graphitic carbon powder, and a graphite powder were fluorinated and then tribologically investigated. In addition, one of the coke powders was reduced in size before fluorinating to evaluate the effect of a finer particle size on the tribological properties. For comparison, graphite and coke powders which were not fluorinated were also tribologically evaluated. Elemental analysis by emission spectroscopy was performed on each sample to determine the impurity content and X-ray diffraction analysis was performed to determine the crystallinity. Coke was found to have very little lubricating ability, but fluorinated coke did possess good lubricating properties. However, the fluorinated graphite and fluorinated graphitic carbon (which gave equivalent results) gave superior results to those obtained with the fluorinated cokes. No tribological benefit was found for using small versus a larger particle size of coke, at least when evaluated as a rubbed film.
Author

**N87-29680#** Case Western Reserve Univ., Cleveland, Ohio. Dept. of Macromolecular Science.
**CHEMICAL DESIGN OF ELASTOMERS Final Report, 1 Jul. 1983 - 30 Dec. 1986**
Jack L. Koening 19 May 1987 70 p
(Contract DAAE07-83-K-R010)
(AD-A182905; TACOM-TR-13264) Avail: NTIS HC A04/MF A01 CSCL 11J

Solid state C-13 nuclear magnetic spectroscopy has been extended to the study of the accelerated sulfur-vulcanization of natural rubber. Natural rubber vulcanizates which had been cured with elemental sulfur only, were studied by this technique. The NMR spectra obtained for these systems provided significant structural information on the natural rubber network. The samples are formulated with sulfur, accelerators and activators in order to study the effects of the various components in the crosslinking

process of natural rubber. The NMR spectra indicate that a simpler network structure is obtained with accelerated sulfur vulcanization as compared to the systems cured with high levels of elemental sulfur. Solution C-13 NMR model compound studies have indicated that polysulfides terminated by accelerator residues will be indistinguishable from polysulfidic crosslinks. In the natural rubber vulcanizates, polysulfidic crosslinks have been observed in addition to the pendant accelerator groups. Cis-to-trans chain isomerization has been found to occur in these vulcanizates. GRA

**N87-29681#** Washington State Univ., Pullman. Dept. of Physics.

**FRACTO-EMISSION FROM POLYMERS Summary Report, 1 Jun. 1985 - 30 May 1987**

J. T. Dickinson 21 Jun. 1987 182 p

(Contract N00014-80-C-0213)

(AD-A183027) Avail: NTIS HC A09/MF A01 CSCL 07B

Progress in the investigation of fracto-emission (FE) from polymers, crystalline materials, and interfaces are presented involving measurements of electron, photon, radiowave, and neutral atom and molecule emissions. We examine FE during the peeling of binder elastomer from single crystals of RDX; these emissions show FE features unique to adhesive failure. We present images of the photon emission during the peeling of adhesives. We also present mass spectroscopic measurements of the neutral particles emitted from the fracture of single crystals of MgO. In an appendix, we present results of simultaneous measurements of photon and electron emission from single crystal MgO. In addition, we present experiments on the consequences of simultaneous exposure of polymers to electron beam radiation and mechanical stress. In these studies we show that cracks can be initiated and/or propagated at stresses lower than critical stress values. The morphology of the stressed polymers plays a key role in the observed response. GRA

**N87-29682#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Tech Center for Adhesion Science.

**AN INTERDISCIPLINARY APPROACH TO PREDICTIVE MODELING OF STRUCTURAL ADHESIVE BONDING, CHROMIC ACID ANODIZED Ti-6Al-4V: ITS CHARACTERIZATION AND ITS SINGLE LAP BOND STRENGTH TO HEAT RESISTANT ADHESIVES Summary Report, Jan. 1982 - Jun. 1987**

Jean A. Skiles and J. P. Wightman Jun. 1987 392 p

(AD-A183054; CAS/CHEM-87-2) Avail: NTIS HC A17/MF A01 CSCL 11A

Anodized Titanium Aluminum Vanadium adhesive bonds exhibit improved corrosion resistance and a higher strength to weight ratio compared to conventional metal bonding techniques for primary and/or secondary structural applications. This work was conducted to identify chromic acid (CA) anodization and bond process conditions which produced durable, structural applications. This work was conducted to identify chromic acid (CA) anodization and bond process conditions which produced durable, structural anodized Titanium Aluminum Vanadium single lap bonds and to understand why these conditions were necessary. Heat resistant adhesives tested had reported service temperatures greater than 423K, and were: polysulfone; polyethersulfone; polyphenyl quinoxaline; polyetherimide, both unfilled and 20% glass filled; and 50% calcium carbonate filled polyimide. Hydrofluoric acid (HF) added to the CA anodization solution was necessary to produce structural bonds. Chromic acid hydrogen fluoride oxide was more porous, and thicker than the CA anodic oxide, perhaps promoting physical and oxide/adhesive interphase mechanical interlock. GRA

**N87-29683#** Massachusetts Univ., Amherst. Dept. of Polymer Science and Engineering.

**RESIST POLYMERS. 9: THERMOLYSIS OF CHLORINE CONTAINING ACRYLATE POLYMERS**

V. L. Rao, Pradeep K. Dhal, G. N. Babu, and James C. Chien Jun. 1987 34 p

(Contract N00014-86-K-0345)

(AD-A183134; TR-4) Avail: NTIS HC A03/MF A01 CSCL 07D

The thermal degradation of poly(chloroethyl methacrylate) (PCEMA), poly(trichloroethyl methacrylate) (PTCEMA), poly-(methyl-alpha-chloroacrylate) (PMCA) and their copolymers with methyl methacrylate (MMA) have been investigated. Both ester decomposition and main chain scission occurs for the chloroalkyl methacrylate polymers with the former playing the dominant role. In contradistinction, HCl elimination and aromatization prevail over other processes for PMCA. The thermolysis results are compared with radiolysis results. GRA

**N87-29684#** Massachusetts Univ., Amherst. Dept. of Polymer Science and Engineering.

**RESIST POLYMERS. 8: THERMOLYSIS OF BROMINE CONTAINING ACRYLATE POLYMERS**

Pradeep K. Dhal, G. N. Babu, and James C. Chien Jun. 1987 36 p

(Contract N00014-86-K-0345)

(AD-A183135; TR-3) Avail: NTIS HC A03/MF A01 CSCL 07C

Thermal decomposition of synthetic polymer can exclude its usage in certain applications. It is often found that the thermal decomposition of polymer can differ significantly from those of model compounds because the chain environment may modify reaction pathways. The thermolysis of bromine containing polymers is particularly interesting because of their role as proven flame retardants. The bromine containing polymers behave differently from the fluorine and chlorine analogs toward energetic radiation as possible candidates for positive electron beam resists. The radiolysis of bromine derivatives have marked tendency toward crosslinking, whereas fluorine containing polymers undergo only main chain scission. Thermal stabilities of these polymers are also important in this application because the requirements to withstand various heat treatment during the manufacturing of VLSI devices. Recently Grassie et al. reported the thermal degradation of poly(2-bromoethyl methacrylate), PBEMA, and blends of PBEMA and poly(methyl acrylate) producing mainly monomer with small amounts of vinyl bromide and carbon dioxide. The central objective of this work is to identify the pyrolysis products of three bromine containing acrylate polymers and their copolymers with MMA and to understand the mechanism of thermal decomposition as compared to that for radiolysis. A further objective is to understand the differences between the thermolysis of bromine and fluorine containing polymers. GRA

**N87-29685#** Manlabs, Inc., Cambridge, Mass.

**APPLICATION OF COMPUTER METHODS FOR CALCULATION OF MULTI COMPONENT PHASE DIAGRAMS OF HIGH TEMPERATURE STRUCTURAL CERAMICS Final Report, Aug. 1984 - Jul. 1987**

Larry Kaufman 31 Jul. 1987 99 p

(Contract F49620-84-C-0078)

(AD-A183174; AFOSR-87-0920TR) Avail: NTIS HC A05/MF A01 CSCL 11B

A data base is being developed for calculation of quasi-binary and quasi-ternary phase diagrams of ceramic systems. Previous segments of this base cover combinations of Cr2O3, MgO, Al2O3, SiO2, CaO, Si3N4, AlN, BeO, Y2O3 and Ce2O3. Sixty -six quasi binary and nineteen quasi ternary systems have been calculated. The current work extends the base to cover GeO2, HfO3, ZrO2 and TiO2 which are of interest in applications requiring toughness and structural performance at high temperatures. This has been effected by employing available source of thermochemical and phase diagram data. Recently it has been shown that by alloying GeO2 with SiO2 a whole range of glasses can be synthesized with tailor-made coefficients of expansion. Utilization of such compositions offers the possibility of enhancing the high temperature oxidation resistance of ceramic composites in a mixed GeO2-SiO2 phase which a desired CTE would replace the conventional SiO2 as a filler. GRA

**N87-29686#** Harvard Univ., Cambridge, Mass. Div. of Applied Sciences.
**SMALL-SCALE CRACK BRIDGING AND THE FRACTURE TOUGHNESS OF PARTICULATE-REINFORCED CERAMICS**
Bernard Budiansky, John C. Amazigo, and Anthony G. Evans Jun. 1987 34 p
(Contract N00014-86-K-0753)
(AD-A183208; MECH-104) Avail: NTIS HC A03/MF A01 CSCL 11B

Theoretical analyses of small-scale bridging of crack surfaces by elastic-ideally plastic springs are presented and applied to the study of the fracture toughness of ceramics reinforced by small particles. The dependence of toughening on particle size, concentration, strength, and ductility is explored, and relations between toughening and bridge length at fracture are given. Availabie experimental information is examined in the light of the analyses. Author (GRA)

**N87-29687#** Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry.
**LOW POLYDISPERSITY HOMO- AND BLOCK COPOLYMERS BY RING-OPENING OF 5,6-DICARBOMETHOXYNORBORNENE**
John S. Murdzek and Richard R. Schrock 31 Jul. 1987 14 p
(Contract N00014-87-K-0099)
(AD-A183245; TR-1) Avail: NTIS HC A02/MF A01 CSCL 07D

Addition of 50-200 eq of norbornene to Mo(CH Superscript t Bu) (NAr) (O Superscript t Bu)2 yields living polymers, Mo(CH(C5H8)CH) sub x CH Superscript t Bu)(NAr)(O Superscript t Bu)2 (55 percent trans), that are stable for days in the absence of water and oxygen with essentially no isomerization of the double bonds in the chain. Addition of benzaldehyde cleaves off the polymer in a Wittig-like reaction to yield polynorbornenes with polydispersities in the range 1.04-1.11. Analogous reactions involving 50-200 eq of endo, endo-5,6-dicarbomethoxynorbornene yields homopolymers with polydispersities in the range 1.11-1.22. Block copolymers containing 50 eq of endo,endo-5,6-dicarbomethoxynorbornene and 200 eq of endo,endo-5,6-dicarbomethoxynorbornene and 200 eq of nonbornene prepared by adding one or the other monomer first are virtually identical (polydispersities 1.06 and 1.09 with M sub n 57200 and 59900, respectively). These results suggest that the molybdenum catalyst will not react significantly with up to 100 eq of ester functionality during the time of a typical polymerization reaction (approx. 15 m at 25 degs.). GRA

**N87-29688#** Burns (Jay) Scientific Consultants, North Indiatlantic, Fla.
**BULK MODULUS OF ELASTICITY OF VARIOUS ELASTOMERS: THEORY AND EXPERIMENT Progress Report, Jul. 1984 - Feb. 1987**
Jay Burns, Pieter S. Dubbelday, and Robert Y. Ting 5 Jun. 1987 36 p
(Contract N62190-M-1169; RR0-1108)
(AD-A183259; NRL-MR-5991) Avail: NTIS HC A03/MF A01 CSCL 11J

A simple theoretical model for the bulk modulus of elastomers based on the free volume concept is described. It gives a static (zero frequency) bulk modulus which exhibits a temperature dependence similar to chain theories of shear and Young's moduli. At higher temperatures, the model gives an Arrhenius-type behavior. The frequency dependence is developed from generalization of a single relaxation time hereditary model using the method applied to dielectric losses in polymers. The result yields simple hyperbolic functional dependencies of the storage and loss moduli on frequency. These functions are consistent with the time-temperature superposition principle and can be used to construct master curves using the WLF frequency shift method. Experimental data have been obtained for a number of rubbery elastomers using an acoustic coupler method. Details of the experimental arrangement are described together with results obtained. Generally, values of the bulk modulus are found to closely resemble those of typical organic liquids. Recent data have permitted construction of master curves for several samples, and the parameters for these curves are given. GRA

**N87-29689#** Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry.
**DISTRIBUTION OF MATRIX HOMOPOLYMER IN BLOCK COPOLYMERS OF SPHERICAL MORPHOLOGY**
C. V. Berney, Paul Cheng, and R. E. Cohen 29 Jul. 1987 27 p
(Contracts N00014-87-K-0517; N00014-77-C-0311)
(AD-A183317; TR-1) Avail: NTIS HC A03/MF A01 CSCL 07B

Samples made by blending deuterated polystyrene Sd of three different molecular weights with a polystyrene-polybutadiene block copolymer SB were studied with small-angle scattering techniques using X-rays (SAXS) and neutrons (SANS). The SANS results were sensitive both to the amount of added homopolymer Sd and to its chain length. Anomalously high SANS intensities and the absence of an intraparticle scattering maximum are consistent with the exclusion of added Sd from the corona of the SB micelles, resulting in Sd enrichment of the interstitial regions. GRA

**N87-29690#** Connecticut Univ., Storrs. Inst. of Materials Science.
**THE EFFECTS OF TEMPERATURE AND PRESSURE ON THE LONGITUDINAL VOLUME VISCOSITY OF TWO MODEL POLYMERS Interim Report, 1-31 Jul. 1987**
Benjamin S. Hsiao, Montgomery T. Shaw, and Edward T. Samulski 30 Jul. 1987 38 p
(Contract N00014-86-K-0772)
(AD-A183319; TR-3) Avail: NTIS HC A03/MF A01 CSCL 07B

A method of studying dynamic longitudinal volume viscosity at high pressure using a modified Instron capillary rheometer is demonstrated. Two model polymers were chosen as examples: an amorphous polysulfone and a semicrystalline high density polyethylene. Volume viscosity was measured at fixed pressure using a continuous temperature sweep. The pressure ranged up to 2000 bar, while temperatures were swept through the liquid to solid transition for each of the materials. The effects of frequency and strain on volume viscosity were also investigated. In both polymer systems, volume viscosity increased as the pressure was increased or the frequency was decreased. In spite of the small strains employed, the viscosity was found to decrease as the strain was increased. The temperature-dependent volume viscosity varied with the nature of the transitions. In polysulfone, volume viscosity decreased sharply with temperature above the glass transition temperature. However, in polyethylene, a positive dependence of volume viscosity on temperature, limited to only a small temperature range above melting temperature was observed. GRA

**N87-29691#** Case Western Reserve Univ., Cleveland, Ohio. Dept. of Macromolecular Science.
**LIQUID CRYSTALLINE POLYMERS BY CATIONIC POLYMERIZATION**
Virgil Percec 1986 22 p
(Contract N00014-86-K-0284)
(AD-A183331; TR-19) Avail: NTIS HC A02/MF A01 CSCL 07B

The synthesis of liquid crystalline polymers and oligomers containing calamitic and disc-like mesogens by cationic polymerization and oligomerization is reviewed. Examples from ring-opening, carbocationic, and radical-cation polymerizations and oligomerizations are discussed. GRA

**N87-29692#** Princeton Univ., N. J. Dept. of Chemical Engineering.
**TIME-TEMPERATURE-TRANSFORMATION (TTT) CURE DIAGRAMS: RELATIONSHIP BETWEEN Tg AND THE TEMPERATURE AND TIME OF CURE FOR A POLYAMIC ACID/POLYIMIDE SYSTEM Technical Report No. 12, 31 Dec. 1984 - 31 Dec. 1986**
G. R. Palmese and J. K. Gillham Jul. 1987 36 p

(Contract N00014-84-K-0021)
(AD-A183385) Avail: NTIS HC A03/MF A01 CSCL 07B

Glass transition temperatures (Tg) were obtained versus isothermal temperature (Tcure) and time of cure for a polyamic acid/polyimide system. A time temperature-transformation (TTT) isothermal cure diagram was constructed to include the time to vitrification and iso-Tg curves. As for epoxies, the relationship between Tcure and the time to vitrification is S-shaped. Plots of Tg versus Tcure show that solvent evaporation and chemical reaction are controlled by vitrification. GRA

**N87-29693#** Case Western Reserve Univ., Cleveland, Ohio. Dept. of Physics.
**DR, TSDC, DSC, TMA, AND DMA STUDIES IN POLYMERS COMPLEXED WITH INORGANIC SALTS Interim Report**
John J. Fontanella, Mary C. Wintersgill, J. P. Calame, and D. R. Figueroa 1 Jul. 1987 13 p
(Contract N00014-87-AF-00001)
(AD-A183411; TR-28) Avail: NTIS HC A02/MF A01 CSCL 07D

The relationship between audio frequency dielectric relaxation (DR) and thermally stimulated depolarization current (TSDC) techniques is described. In addition, those methods are compared with differential scanning calorimetry (DSC), thermo-mechanical analysis (TMA) and dynamic mechanical analysis (DMA). The discussion will proceed using data taken on cast film samples of PAREL elastomer. GRA

**N87-29694#** Connecticut Univ., Storrs. Inst. of Materials Science.
**PRESSURE-INDUCED PHASES IN A THERMOTROPIC POLYESTER Interim Report, 1-31 Jul. 1987**
B. S. Hsiao, M. T. Shaw, and E. T. Samulski 30 Jul. 1987 19 p
(Contract N00014-86-K-0772)
(AD-A183424; TR-2) Avail: NTIS HC A02/MF A01 CSCL 07B

Studies of a copolyester of 20% hydroxybenzoic acid, 40% isophthalic acid and 40% hydroquinone, a mesomorphic polymer, were carried out under pressure. The phase behavior was characterized by the x-ray diffraction, thermal analysis and high pressure DTA techniques. It was found that pressure induced a new crystal habit in the solid and a new mesophase in this polymer. All thermal transitions have been summarized in a proposed phase diagram. The finding of pressure induced mesomorphism confirms the possibility of extending the range of polymers which might exhibit liquid crystallinity. GRA

**N87-29695#** Case Western Reserve Univ., Cleveland, Ohio. Dept. of Macromolecular Science.
**LIQUID CRYSTALLINE POLYMERS CONTAINING HETEROCYCLOALKANE MESOGENIC GROUPS. PART 5: SYNTHESIS OF BIPHASIC CHIRAL-SMECTIC POLYSILOXANES CONTAINING 2,5-DISTRIBUTED-1,3-DIOXANE AND 2,5-DISUBSTITUTED-1,3,2-DIOXABORINANE BASED MESOGENIC GROUPS**
Bruce Hahn and Virgil Percec 1987 40 p
(Contract N00014-86-K-0284)
(AD-A183435; TR-10) Avail: NTIS HC A03/MF A01 CSCL 07B

The synthesis of side-chain liquid crystalline polysiloxanes containing chiral mesogenic side-groups, is presented. Differential scanning calorimetry and optical polarization microscopy revealed chiral smectic mesomorphism for all polymers. The last two polymers present also a chiral smectic-C mesophase. All copolymers exhibit two glass transition temperatures; one due to the independent motion of the main chain, the other due to the cooperative but independent motion of the side-groups. Therefore, these liquid crystalline copolymers are biphasic systems resembling the behavior of phase separated graft copolymers, i.e., they exhibit a micro-phase separated morphology containing main-chain and side-chain domains. GRA

**N87-29696#** Rutgers - The State Univ., Piscataway, N. J. High Pressure Materials Research Lab.
**[PHYSICAL AND MECHANICAL PROPERTIES OF POLYMERS UNDER HYDROSTATIC PRESSURE] Final Report**
Kook D. Pae, B. A. Newman, and J. I. Scheinbeim 15 Jul. 1987 7 p
(Contract N00014-75-C-0540)
(AD-A183458) Avail: NTIS HC A02/MF A01 CSCL 11I

A great deal of research has been done and significant progress made on the effects of hydrostatic pressure on various aspects of physical and mechanical properties of polymers. The areas of interests included high pressure x-ray studies, high pressure DTA studies, high pressure effects on mechanical properties, pressure-volume-temperature relations, high pressure crystallization, and high pressure effects on piezoelectricity and pyroelectricity. The results of the research have been published in ONR Technical Reports and numerous journal publications listed in this report. GRA

**N87-29697#** Cincinnati Univ., Ohio. Dept. of Materials Science and Engineering.
**STRUCTURE AND PROPERTIES OF POLYMER INTERPHASES Annual Report, 1 Jul. 1986 - 30 Jun. 1987**
F. J. Boerio 1 Aug. 1987 37 p
(Contract N00014-85-R-0459)
(AD-A183559; AR-2) Avail: NTIS HC A03/MF A01 CSCL 07F

Infrared spectroscopy was used to determine the effect that metal substrates such as titanium, steel, 1100-series aluminum, 2024 aluminum, and copper have on the molecular structure and properties of gamma-amonopropyl triethoxysilane (gamma-APS) primer films. When gamma-APS was absorbed onto any of the substrates from aqueous solutions at pH 10.4 for one minute and then dried at room temperature for thirty minutes, the molecular structure of the primer films was similar and consisted of low molecular weight siloxane polymers containing a considerable amount of absorbed carbon dioxide in the form of amine bicarbonates. When drying was carried out at 110 C, films formed on titanium, steel, and 1100-series aluminum were similar. The extent of polymerization in the films increased and most of the bicarbonates were dissociated. However, the amino groups in films formed on 2024 aluminum and copper oxidized to imine groups and the polymerization did not increase significantly. After drying at 150 C, the films formed on titanium, steel, and 2024 aluminum were all oxidized to the imine but the oxide on 1100-series aluminum inhibited the free radical oxidation reaction. Dissociation of the bicarbonates and oxidation of the amino groups were important factors in the reaction of the primers with epoxy resins. GRA

**N87-29698#** Texas Christian Univ., Fort Worth. Dept. of Chemistry.
**BORON-NITROGEN POLYMER PRECURSORS**
S. Y. Shaw, Donn A. DuBois, and Robert H. Neilson 11 Aug. 1987 9 p
(Contract N00014-79-C-0632)
(AD-A183560; TCU/DC/TR-87-01) Avail: NTIS HC A02/MF A01 CSCL 11B

The synthesis of tractable, linear B-N polymers (RBNR) is usually prevented by the ready formation of the extremely stable trimeric borazene ring system (RBNR). In an attempt to circumvent this problem, we have prepared a series of new mono- and diboryl-amines, by lithiation of the 1,3,2- diazobora cyclohexane ring system followed by quenching with electrophiles. The crystal and molecular structure has been determined by single crystal X-ray diffraction. Further chemistry of these compounds has been explored by reactions involving their pendent groups. For example, the bis(trimethylsilyl) compound 5 reacts with PhBCl2 via bond cleavage. Also, the bis(dimethyl amino)boryl derivative undergoes transamination reactions with 1,3-diaminopropane to give compounds containing two or three BN2C3 rings linked together. Preliminary thermolysis studies show that some of the diborylamines are potentially useful precursors to boron-nitrogen oligomers/polymers. GRA

**N87-29699#** Pennsylvania Univ., Philadelphia. School of Engineering and Applied Science.
**THE TRANSITION FROM BRITTLE TO DUCTILE FAILURE IN POLYETHYLENES M.S. Thesis**
John L. Donofrio Aug. 1987 174 p
(AD-A183776) Avail: NTIS HC A08/MF A01 CSCL 11I

The evolution of notch-tip damage to failure of two polyethylenes associated with pipe manufacture, at various stress levels characterizing the competition between brittle and ductile modes of failure is studied. The failure behavior of polyethylene is studied as the stress is increased, approaching the yield point where failure is in the ductile mode. The mechanical behavior of polyethylene is explored as the transition from brittle failure to ductile failure occurs. This project provides for a continuation of earlier research by studying the characteristics of the failure of polyethylene exposed to stress levels from about one half and up to the yield point. In order to provide a continuity in results, experiments were conducted on Marlex 6006, the same material used in previous research. Also studied was TR 418, a branched polyethylene, typical of the material used in the actual manufacture of gas pipe. The experimental parameters that were varied were stress, notch depth, temperature, and material. Quantitative measurements were made with an optical microscope fitted with a filar objective, a strain guage extensometer, a thermocouple, timer, and a digital data collector. GRA

**N87-29700#** Foster-Miller Associates, Inc., Waltham, Mass.
**NET-SHAPE TUBULAR STRUCTURES FROM ORDERED POLYMERS Final Report, 15 Nov. 1986 - 12 Jun. 1987**
Richard W. Lusignea and James L. Racich 12 Jun. 1987 80 p
(Contract N00014-86-C-0849)
(AD-A183867; NAV-0849-FM-8690) Avail: NTIS HC A05/MF A01 CSCL 11B

Ordered polymers can be used to make very lightweight, high modulus tubes with near-zero coefficient of thermal expansion (CTE) in the axial direction. These tubes and joints will be the building blocks of SDI space structures. Net-shape processing will produce thin-walled (0.050 in. or less) tubes with the proper orientation built in by a special extrusion process combined with interpenetrating network (IPN) materials which provide reinforcement at a submicron level. Ordered polymer tubes were extruded with controlled biaxial orientation and IPN materials were produced using sol-gel glass processing methods. The combination of controlled microstructure orientation and reinforcement at the molecular level produces a new form of materials with outstanding properties, tailorability, and rapid fabrication. GRA

**N87-29701#** Connecticut Univ., Storrs. Inst. of Materials Science.
**CHARACTERIZATION OF SURFACE STRUCTURE AND PROPERTIES IN ORIENTED POLYMERS**
N. H. Sung, H. Y. Lee, P. Yuan, and C. S. Sung 24 Jul. 1987 12 p
(Contract N00014-86-K-0200)
(AD-A183894; TR-8) Avail: NTIS HC A02/MF A01 CSCL 11B

New surfaces generated during unaxial or biaxial stretching of polymer films are substantially different from their unoriented counterparts. Changes in surface structure have been characterized by measuring molecular orientation and degree of crystallinity using FT-IR ATR dichroism technique. Surface properties, such as surface tension and friction coefficient, are studied by measuring contact angles and by single-stroke friction measurements. Uniaxial drawing increases surface crystallinity and molecular orientation in both polypropylene (PP) and polyethyleneterephthalate (PET). This also leads to anisotropic friction coefficients when measured parallel and perpendicular to the drawing direction. Contact angles measured with four different liquids also exhibit anisotropy in oriented PP and not in PET. Surface roughness of drawn PP is directional whereas that of PET is uniform. And the possible influence of anisotropic roughness on contact angle measurements are carefully examined. Attempts are made to correlate surface properties with surface structural parameters. GRA

# 28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

**N87-29702#** Oklahoma Univ., Norman. School of Chemical Engineering and Materials Science.
**DEVELOPMENT OF AN EQUATION OF STATE FOR COMPUTATION OF SUPERCOMPRESSIBILITY FACTORS, CRITICAL FLOW FACTORS AND OTHER PROPERTIES FOR WET, SOUR NATURAL GASES, SYNTHETIC GASES AND ADMIXTURES Annual Report, Oct. 1985 - Sep. 1986**
K. E. Starling, J. L. Savidge, S. Shankar, and T. Reid Sep. 1986 15 p
(Contract GRI-5084-260-1010)
(PB87-209987; GRI-86/0280) Avail: NTIS HC A02/MF A01 CSCL 21D

The equation of state developed for sweet/dry natural gases was used to predict the sonic velocity of pure methane and other pure systems for which data exist. In the region of interest to sonic nozzle calculations, excellent agreement was obtained between pure methane experimental sonic velocities and the calculated sound speeds from the equation of state with agreement often better than 0.05 percent. At low temperatures (less than 250 K) and pressures near the critical pressure of methane significant differences between calculated sonic velocities and experimental sound speeds were found. This suggests the equation of state could be improved, if deemed necessary, for this region. To date, accurate speed or sound measurements for actual natural gas mixtures were not made. This severely limits testing the equation of state beyond the limited amount of pure component data until mixture data become available. A computer program was developed to predict all the important properties used in sonic nozzle calculations. GRA

**N87-29703#** Louisiana State Univ., Baton Rouge. Dept. of Physics and Astronomy.
**DETONATIONS OF SOLID EXPLOSIVES Final Report, 1 Feb. 1985 - 31 Jan. 1987**
Nathan E. Brener 5 May 1987 43 p
(Grant AF-AFOSR-0142-85)
(AD-A182934; AFOSR-87-0874TR) Avail: NTIS HC A03/MF A01 CSCL 19A

The goal of this project is to calculate the amount of shocking or jostling that a solid explosive can withstand before detonating. The ultimate objective is to determine, by means of the calculations, how to modify the explosive so that it still retains all of its explosive power but becomes less sensitive to shock. These less sensitive but equally powerful explosives would reduce the number of accidents that occur among personnel involved in handling, storing, transporting, and using the explosives. The detonation process is complicated and involves many factors, including hot spots, propagation of acoustic or detonation waves, interaction (or scattering) between detonation waves and explosive molecules, etc. However, the key factor in an explosive's sensitivity to shock is the activation energy of the molecules that make up the explosive. When an explosive receives a shock, the energy of the molecules contained in the explosive is increased. In the region of the shock, if the energy of a sufficient number of molecules is raised above the activation energy, then the detonation begins. GRA

**N87-29704#** National Bureau of Standards, Gaithersburg, Md. Ceramics Div.
**HIGH TEMPERATURE CHEMISTRY OF STORED CHEMICAL ENERGY REACTIONS FOR PROPULSION Annual Report, 25 May 1985 - 31 Dec. 1986**
L. P. Cook, E. R. Plante, D. W. Bonnell, and J. W. Hastie Jul. 1987 57 p
(Contract N00014-85-F-0144)
(AD-A183010; NBSIR-87-3601) Avail: NTIS HC A04/MF A01 CSCL 19A

(AD-A183010; NBSIR-87-3601) Avail: NTIS HC A04/MF A01 CSCL 19A

This report summarizes the results of a continuing study of the high temperature chemistry of stored chemical energy reaction systems. Thermogravimetric studies have been completed on the behavior of Aluminum oxide and Magnesium oxide in the presence of ClO3F. Based on these data a new ceramic containment system comprised of alumina and magnesia parts has allowed extension of kinetic experiments from the 650 C limit previously encountered to a temperature in excess of 800 C. Using the new apparatus, we have observed the relative inertness of the Al component of the fuel to oxidation by ClO3F even at 800 C. We have also noted the extensive vapor phase transport of Lithium fluoride and Magnesium flouride not expected on the basis of known thermodynamic data. Thermogravimetric experiments have been completed on the oxidation of molten aluminum droplets by ClO3F. Rate data for this reaction indicate multiple mechanisms, possibly including the following steps: (1) nucleation and growth of AlF3 precipitation sites; (2) edge growth of AlF3 islands followed by coalescence of islands; (3) and diffusion limited thickening of the AlF3 layer. Observations on the early stages of the Al/ClO3F reaction have also been made using high pressure sampling transpiration mass spectrometry. GRA

**N87-29705#** Army Chemical Research and Development Center, Aberdeen Proving Ground, Md.

**THE APPLICATION OF SOLID STATE PHYSICS PRINCIPLES TO PYROTECHNIC MIXTURE SYSTEMS Technical Report, Nov. - Dec. 1985**

Cecil D. Hassell Jun. 1987 22 p

(AD-A183762; CRDEC-TR-87048) Avail: NTIS HC A02/MF A01 CSCL 21B

The object of this work was to apply simple principles of solid state physics to the functional performance of various types of pyrotechnic mixtures. Some of these parameters are particle size, loading density/pressure, and thermal conductivity. GRA

**N87-29706*#** Drexel Univ., Philadelphia, Pa. Dept. of Mechanical Engineering and Mechanics.

**THERMAL STABILITY OF DISTILLATE HYDROCARBON FUELS Ph.D. Thesis**

Kishenkumar Tadisina Reddy and Nicholas P. Cernansky Oct. 1987 196 p

(Grant NAG3-183)

(NASA-CR-181412; NAS 1.26:181412) Avail: NTIS HC A09/MF A01 CSCL 21D

Thermal stability of fuels is expected to become a severe problem in the future due to the anticipated use of broadened specification and alternative fuels. Future fuels will have higher contents of heteroatomic species which are reactive constituents and are known to influence fuel degradation. To study the degradation chemistry of selected model fuels, n-dodecane and n-dodecane plus heteroatoms were aerated by bubbling air through the fuels amd stressed on a modified Jet Fuel Thermal Oxidation Tester facility operating at heater tube temperatures between 200 to 400 C. The resulting samples were fractionated to concentrate the soluble products and then analyzed using gas chromatographic and mass spectrometric techniques to quantify and identify the stable reaction intermediate and product specifically. Heteroatom addition showed that the major soluble products were always the same, with and without heteroatoms, but their distributions varied considerably. Author

# 29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.

For biological materials see *55 Space Biology*.

**N87-29707#** Battelle Inst., Frankfurt am Main (West Germany).

**INVESTIGATION OF THE OSTWALD RIPENING OF SEPARATED PARTICLES IN LIQUID-LIQUID SYSTEMS UNDER MICROGRAVITY CONDITIONS, PHASE 2 Final Report, May 1984**

Michael Harr Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 61 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(BMFT-FB-W-86-026; ISSN-0170-1339; ETN-87-90328) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 12.50

Procedures for the generation of liquid precipitates of 20 micrometer diameter, suspended in a liquid matrix, were developed and tested. The generation of particles from a reservoir of the precipitating component with interface to the matrix, or by precipitation is explained. The suitability of the procedures for the generation of particle configurations for the observation of Ostwald ripening under normal gravity and microgravity conditions is discussed on the basis of theoretical concepts for Ostwald ripening. ESA

**N87-29708#** Giessen Univ. (West Germany). Inst. fuer Physik.

**THE CRITICAL MARANGONI NUMBER FOR THE TRANSITION FROM STEADY TO OSCILLATORY THERMOCAPILLARY CONVECTION IN FLOAT ZONES UNDER MICROGRAVITY CONDITIONS Final Report, Apr. 1986**

Dietrich Schwabe and Arthur Scharmann Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 48 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(Contract BMFT-01-QV-148-ZA-SN-SLN-7786)

(BMFT-FB-W-86-028; ISSN-0170-1339; ETN-87-90330) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 9

The critical Marangoni number of the transition from steady to oscillatory thermocapillary convection was measured in liquid bridges (float zones) made of NaNO3, under microgravity during the free-flying phase of SPAS-01. The critical Marangoni numbers of the NaNO3 zones (diameter 5 mm, length 4.79 and 4.0 m) are found to range between 9000 and 9600. The critical Marangoni numbers of the 1g reference experiments are of the same order of magnitude. The dependence of the oscillation frequency on the Marangoni number was determined. Frequency jumps and beat frequency are found to occur under microgravity as well as under 1g conditions. ESA

**N87-29709#** Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.

**EFFECTS ON ADVANCED MATERIALS: RESULTS OF THE STS-8 EOIM (EFFECTS OF OXYGEN INTERACTION WITH MATERIALS) EXPERIMENT**

M. J. Meshishnek, W. K. Stuckey, J. S. Evangelides, L. A. Feldman, and R. V. Peterson 20 Jul. 1987 89 p

(Contract F04701-85-C-0086)

(AD-A182931; TR-0086(6935-05)-2; SD-TR-87-34) Avail: NTIS HC A05/MF A01 CSCL 11D

A variety of materials were exposed to the low Earth orbit space environment on shuttle flight STS-8 as a part of NASA's Effects of Oxygen Atoms Interaction with Materials experiment. These materials include carbon and graphites, optical materials, organic and metal films, Kevlar and fiberglass fabric, and high-temperature coatings. The effects noted on these materials included oxidative erosion of the carbon and graphite, loss of tensile strength for the Kevlar fabric, erosion and oxidation of organic films, partial oxidation of infrared optical materials, and loss of reflectance for the high-temperature coatings. GRA

# 31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

**N87-29710#** California Inst. of Tech., Pasadena. Jet Propulsion Center.
**ENTRAINMENT, CHEMISTRY AND STRUCTURE OF FIRE PLUMES**
S. J. Toner, E. E. Zukoski, and T. Kubota Apr. 1987 223 p
(Grant NANB-600638)
(PB87-201851; NBS/GCR-87/528) Avail: NTIS HC A10/MF A01 CSCL 13L

The chemistry of a flame as it impinges on a hot vitiated atmosphere is examined. Several of the products of combustion (CO, soot, etc.) are measured as a function of flame impingement, length of the flame below the hot layer and size of the fire. GRA

**N87-29711#** Maryland Univ., College Park. Dept. of Mechanical Engineering.
**TRANSIENT CHARACTERISTICS OF UNCONFINED FIRE-PLUME-DRIVEN CEILING JETS Annual Report**
C. H. Marks and V. Motevalli Apr. 1987 115 p
(Grant NANB-5H0551)
(PB87-201810; NBS/GCR-87/529) Avail: NTIS HC A06/MF A01 CSCL 13B

The system employs thermocouples to measure both temperatures and velocities at eight locations from the ceiling simultaneously. In this way, velocity and temperature profiles can be obtained in the ceiling jets as a function of time. The velocities are obtained by using pairs of thermocouples, one located downstream of the other, and cross correlating their temperature-time records to obtain the length of time that it takes for fluid to flow from one thermocouple to the other. Preliminary results indicate that the system works well; measurements made thus far compare favorably with steady-state data in the literature. Calibration work on the instrument is continuing and further transient ceiling jet measurements will be obtained. GRA

**N87-29712*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**PRESSURE RIG FOR REPETITIVE CASTING Patent Application**
Peter Vasquez, inventor (to NASA), William R. Hutto, inventor (to NASA), and Albert R. Philips, inventor (to NASA) 30 Jun. 1987 7 p
(NASA-Case-LAR-13485-1; NAS 1.71:LAR-13485-1; US-Patent-Appl-SN-067846) Avail: NTIS HC A02/MF A01 CSCL 13H

The invention relates to a pressure rig for repetitive casting of metals. The pressure rig performs like a piston for feeding molten metal into a mold. Pressure is applied to an expandable rubber diaphragm which expands like a balloon to force the metal into the mold. A ceramic cavity which molds molten metal is lined with blanket-type insulating material, necessitating only a relining for subsequent use and eliminating the lengthy cavity preparation inherent in previous rigs. In addition, the expandable rubber diaphragm is protected by the insulating material thereby decreasing its vulnerability to heat damage. As a result of the improved design the life expectancy of the pressure rig contemplated by the present invention is more than doubled. Moreover, the improved heat protection has allowed the casting of brass and other alloys with higher melting temperatures than possible in conventional pressure rigs. NASA

**N87-29713*#** Catholic Univ. of America, Washington, D.C. Dept. of Mechanical Engineering.
**EFFECT OF BONDING ON THE PERFORMANCE OF A PIEZOACTUATOR-BASED ACTIVE CONTROL SYSTEM**
A. Baz and S. Poh 28 Oct. 1987 36 p
(Grants NAG5-520; NAG5-749)
(NASA-CR-181414; NAS 1.26:181414) Avail: NTIS HC A03/MF A01 CSCL 13H

The utilization of piezoelectric actuators in controlling the structural vibrations of flexible beams is studied. A Modified Independent Modal Space Control (MIMSC) method is devised to select the optimal location, control gains and excitation voltage of the piezoelectric actuators in a way that would minimize the amplitudes of vibrations of beams to which these actuators are bonded, as well as the input control energy necessary to suppress these vibrations. The presented method accounts for the effects that the piezoelectric actuators and the bonding layers have on changing the elastic and inertial properties of the flexible beams. Numerical examples are presented to illustrate the application of the MIMSC method and to demonstrate the effect of the physical and geometrical properties of the bonding layer on the dynamic performance of the actively controlled beams. The obtained results emphasize the importance of the devised method in designing more realistic active control systems for flexible beams, in particular, and large flexible structures in general. Author

**N87-29714#** National Bureau of Standards, Gaithersburg, Md. Center for Fire Research.
**AN OVERVIEW OF SMOKE CONTROL TECHNOLOGY**
John H. Klote Sep. 1987 27 p
(NBSIR-87-3626) Avail: NTIS HC A03/MF A01

Considerable advances in smoke control technology have taken place in the last few decades. However, smoke control is just beginning to take its proper place as a fire protection tool. This paper provides an overview of this technology including discussions of the fundamental principles, stairwell pressurization, zone smoke control, elevator smoke control, system activation, and acceptance testing. In addition, the problems of smoke purging are addressed. Author

**N87-29484#** Norwegian Defence Research Establishment, Kjeller.
**AN INTELLIGENT MULTI-TARGET TRACKING SYSTEM**
E. Heyerdahl *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 9 p (For primary document see N87-29474 24-04)
Copyright Avail: NTIS HC A07/MF A01

**N87-29648#** British Aerospace Public Ltd. Co., Bristol (England). Production Improvements.
**DESIGNING FOR SUPERPLASTIC ALLOYS**
D. Stephen *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 37 p (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

**N87-29649#** Alcan International Ltd., London (England).
**THE MANUFACTURE OF SUPERPLASTIC ALLOYS**
R. Grimes *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 16 p (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

# 32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

**N87-29715** Communications Research Centre, Ottawa (Ontario). Information Processing Research.
**DIGITAL TRANSMISSION OVER VIDEO CHANNELS: TELETEXT FIELD MEASUREMENTS**
Bernard Caron Nov. 1986 60 p
(CRC-1420; ISBN-0-662-15524-6) Copyright Avail: Issuing Activity

The results from field measurements made to evaluate the performance of digital transmission over television channels (teletext) were presented and the possible means of improvement identified. The television and teletext signal parameters and test signals used in measuring system performance were reviewed. The results of the measurements, performed across Canada, are used to indicate the teletext reception conditions for different situations. Different factors and parameters affecting teletext performance are also studied. Image grade and eye diagrams are shown to give indications about the teletext service quality to be expected. The VHF and UHF transmission of the teletext signal offered similar performances. Small bidirectional antennas are a poor choice for teletext reception. Quasi-synchronous demodulators result in performance close to those obtained with synchronous models. The study of teletext error statistics shows that a code correcting 2 single errors per line would be sufficient for the majority of cases. Possible improvements are suggested. Two ways are proposed to estimate the bit error rate. Author

**N87-29716#** Los Alamos National Lab., N. Mex.
**KINETIC AND FLUID THEORY OF MICROWAVE BREAKDOWN IN AIR**
R. A. Roussel-Dupre, T. Murphy, and A. Johnson 1987 5 p
Presented at the 18th International Conference on Phenomena in Ionized Gases, Swansea, England, 13 Jul. 1987
(Contract W-7405-eng-36)
(DE87-005104; LA-UR-87-156; CONF-870723-2) Avail: NTIS HC A02/MF A01

We have developed time-dependent fluid and kinetic treatments of electron transport in air in the presence of a propagating microwave pulse. In both cases the HPM pulses are assumed to be of short enough duration so that electron spatial diffusion can be neglected. In addition, we limit our calculations to the non-relativistic regime where effects due to the ponderomotive force are negligible. DOE

**N87-29717#** National Telecommunications and Information Administration, Annapolis, Md.
**BASEBAND PERFORMANCE DEGRADATION DUE TO INTERFERENCE IN THE FIXED-SATELLITE SERVICE**
C. Filippi Aug. 1986 188 p
(PB87-203758; NTIA-86-198) Avail: NTIS HC A09/MF A01
CSCL 17B

A set of receiver transfer characteristic (RTC) algorithms developed at the National Telecommunications and Information Administration (NTIA) for the analytical assessment of mutual interference effects in satellite communication services is described. The RTC algorithms convert the input carrier-to-interference power ratios (C/I) and modulation specifications of the desired (C) and interferer (I) signals into an output baseband performance degradation. The RTC algorithms also compute a C/I threshold margin for a given output baseband performance requirement. The modulation types and communication services include: companded single-sideband, amplitude-modulation, multichannel telephony; regular or companded, frequency-modulated analog television; digital coherent multiple-phase-shift keying; single-channel-per-carrier with digital coherent multiple-phase-shift keying; and single-channel-per-carrier with frequency-modulating analog voice. GRA

**N87-29718*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**SWITCHED STEERABLE MULTIPLE BEAM ANTENNA SYSTEM Patent Application**
Richard S. Iwasaki, inventor (to NASA) (Axiomatix, Los Angeles, Calif.) 10 Jun. 1987 37 p
(NASA-Case-MSC-20873-1-SB; NAS 1.71:MSC-20873-1-SB; US-Patent-Appl-SN-060196) Avail: NTIS HC A03/MF A01
CSCL 17B

A steerable multibeam five element cross-feed cluster antenna system is described. The feed power is divided into five branches. Each branch includes a switching network comprised of a plurality of time delay elements each individually controlled by a respective electromagnetic latching switch. Frequency independent individual two-dimensional beam steering at intermediate (IF) scanning frequencies is thereby provided wherein discrete incremental time delays are introduced by the switching networks into each branch and the signals recombined thereafter to form each beam. The electromagnetic latched switching reduces power consumption and permits higher power switching and reciprocal coincident transmit and receive operation. Frequency independence due to incremental time delay switching permits coincident reciprocal operation and steering for transmit-receive signal paths carrying different transmit-receive frequencies. Diagonal quarter wave plates in the wave guides alter polarization from the circular to orthogonal linear to provide transmitter-receiver isolation. NASA

**N87-29719#** Lawrence Livermore National Lab., Calif.
**IMPEDANCE EFFECTS ON ELECTROMAGNETIC SUSCEPTIBILITY**
W. C. Ng and R. J. King Jun. 1987 33 p
(Contract W-7405-eng-48)
(DE87-011900; UCID-21095) Avail: NTIS HC A03/MF A01

This report studies the impedance effects on electromagnetic susceptibility for various loading conditions. From measurements of the self-impedance (Z sub A) and received voltage across 50 ohms at the terminals of a generic test object, a Thevenin equivalent circuit model is derived. Then, using this model, the load voltage, current, spectral energy density and accumulated energy are computed for several interesting load impedances. Of interest are two worst cases where the load impedance is the complex conjugate of Z sub A and the conjugate pure reactance of Z sub A. Another case of particular interest is where the load impedance is that of an electronic unit representing that of a typical subsystem designed for operation at much lower frequencies. These three cases are compared with the voltage, current and energy at a 50 ohm load. It is concluded that the load voltage, current, spectral energy density and accumulated energy of the two conjugate cases can be one or two orders of magnitude larger than that for the 50 ohm case as might be expected. However, load voltage, current, and spectral energy density at the input of the electronic units tested are comparable to that of the 50 ohm case. The spectral energy density responses are generally within a factor of two (+/- 3 dB), but may be as large as a factor of three (+/- 5 dB) over narrow frequency bands. DOE

**N87-29720#** Lawrence Livermore National Lab., Calif.
**PHENOMENOLOGY OF ELECTROMAGNETIC COUPLING: CONDUCTORS PENETRATING AN APERTURE**
D. B. Wright and R. J. King Jun. 1987 44 p
(Contract W-7405-eng-48)
(DE87-011901; UCID-21087) Avail: NTIS HC A03/MF A01

The purpose of this study was to investigate the coupling effects of penetrating conductors through free-standing apertures. This penetrating conductor and aperture arrangement are referred to as a modified aperture. A penetrating conductor is defined here to be a thin, single wire bent twice at 90° angles. The wire was inserted through a rectangular aperture in a metal wall. Vertical segments on both sides of the wall coupled energy from one region to the other. Energy was incident upon the modified aperture from what is referred to as the exterior region. The amount of coupling was measured by a D sensor on the other (interior) side of the wall. This configuration of an aperture in a metal wall was used as opposed to an aperture in a cavity in order to simplify the interpretation of resulting data. The added complexity of multiple cavity resonances was therefore eliminated. Determining the effects of penetrating conductors on aperture coupling is one of several topics being investigated as part of on-going research at Lawrence Livermore National Laboratory on the phenomenology of electromagnetic coupling. These phenomenology studies are concerned with the vulnerability of electronic systems to high intensity electromagnetic fields. The investigation is relevant to high altitude EMP (HEMP), enhanced HEMP (EHEMP), and high power microwave (HPM) coupling. DOE

**N87-29721#** Technische Univ., Berlin (West Germany). Fachbereich fuer Elektrotechnik.
**AXISYMMETRICAL MULTIPLE-FEED LINEAR ANTENNA AS UNIPOLE ACCORDING TO THE LOG PERIODIC PRINCIPLE Ph.D. Thesis [ROTATIONSSYMMETRISCHE MEHRFACHGESPEISTE LINEARANTENNE ALS RUNDSTRAHLER NACH DER LOGARITHMISCH PERIODISCHEN PRINZIP]**
Gernot Zimmer 1986 140 p In GERMAN
(ETN-87-90029) Avail: NTIS HC A07/MF A01

The electrical characteristics of a log periodic omnidirectional antenna, and its practical realizability were analyzed. The mathematical model, based on the method of moments and the transmission equations, shows the typical current distribution and power output characteristics of a log periodic antenna. However, the required frequency independence of the directional diagram was not obtained. The realization of the structure using a three-wire system shows the required radiation direction, but also a substantial variation in the frequency dependence of the input resistance, making the technical use of the antenna not meaningful. It is shown that the frequency dependence of the input resistance occurs only if the antenna stores the complete reactive power. Since this storage is necessary to obtain the required main radiation direction, it seems to be impossible to construct a log periodic axisymmetric unipole with a frequency independent resistance. ESA

**N87-29722#** Environmental Research Inst. of Michigan, Ann Arbor.
**CALIBRATED L-BAND TERRAIN MEASUREMENTS AND ANALYSIS PROGRAM Final Report, Apr. 1984 - Jan. 1987**
R. W. Larson, E. S. Kasischke, and A. L. Maffett 1 Mar. 1987 106 p
(Contract F19628-84-C-0081)
(AD-A182917; ERIM-174200-16-F) Avail: NTIS HC A06/MF A01 CSCL 17I

This report discusses the final year's activities of a program to generate and analyze L-band clutter data. The L-band radar data used throughout this study were derived from airborne synthetic aperture radar imagery. Radar cross section measurements from a variety of distributed targets are presented, including sea surface, sea ice, agricultural fields and forests. Both HH and VV polarized data are presented. Models are presented which describe the intensity distribution of the SAR data as well as describe L-band scattering from rough surfaces. The density distribution models describe the observed SAR intensity distributions quite well, whereas the radar scattering models in some cases overpredict the SAR-observed values. Author (GRA)

**N87-29723#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**TRANSMISSION OF DIGITAL INFORMATION ALONG CHANNELS WITH THE STORAGE (SELECTED ARTICLES)**
16 Jul. 1987 44 p Transl. into ENGLISH from mono. Peredacha Tsifrovoy Informatsii po Kanalam s Pamyatyu (Moscow, USSR), 1970 p 76-85, 86-92
(AD-A182951; FTD-ID(RS)T-0534-87) Avail: NTIS HC A03/MF A01 CSCL 17B

Repeated codes are not new. In this work Elayes shows that with independent errors the probability of erroneous decoding is now conveniently small at constant velocity transmission, if the length and dimension of the repeated code grows without limit. The relationship of the parameters of the repeated code with the parameters of its subcodes was investigated by Slepian. Repeated and cascade codes can successfully be used both in channels with independent errors and in channels with errors inclined to grouping. In the general case the decoding of the repeated and cascade codes is simplified due to their step by step decoding, i.e., first codes of the first stage are decoded, and then the second. However, the analysis of how the corrective properties of the repeated or cascade code are fully realized when this method is missing in the literature. GRA

**N87-29724#** Naval Research Lab., Washington, D.C.
**CODED FH/SS (FREQUENCY-HOPPED SPREAD-SPECTRUM) COMMUNICATIONS IN THE PRESENCE OF COMBINED PARTIAL-BAND NOISE JAMMING, RICIAN NONSELECTIVE FADING AND MULTIUSER INTERFERENCE Interim Report, May 1985 - Aug. 1986**
Evaggelos Geraniotis and Jeffrey W. Gluck 30 Jun. 1987 34 p Previously announced as A87-30261
(AD-A183068; NRL-9039) Avail: NTIS HC A03/MF A01 CSCL 17D

In this report, we address the problem of combatting combined interference in spread-spectrum communication links. We consider frequency-hopped spread-spectrum systems with M-ary FSK modulation and noncoherent demodulation that use forward-error control coding. The interference consists of partial-band noise jamming, nonselective Rician fading, other-user interference, and thermal noise. The coding schemes that we analyze include: Reed-Solomon codes (with or without diversity and error/only), erasure-error or parallel erasure/error decoding); binary, nonbinary, and dual-k convolutional codes with or without side information (information about the state of the channel); and concatenated schemes (Reed-Solomon outer codes with either inner detection-only block codes or inner convolutional codes). In all cases, we derive the minimum signal-to-jammer energy ratio required to guarantee a desirable bit error rate as a function of the fraction of the band that is jammed when the number of interfering users is fixed, and the maximum number of users that can be supported by the system as a function of the fraction of the band that is jammed, when the signal-to-jammer energy ratio is fixed, are determined. Author (GRA)

**N87-29725#** Princeton Univ., N. J.
**SIGNAL PROCESSING ALGORITHMS Final Report, 1 Aug. 1981 - 30 Jul. 1986**
Bede Liu 3 Apr. 1987 6 p
(Grant AF-AFOSR-0186-81)
(AD-A183131; AFOSR-87-0931TR) Avail: NTIS HC A02/MF A01 CSCL 17B

Research was conducted on mathematical problems related to signal processing. An explicit expression for the mean square error in the signal extrapolation problem has been obtained. An interactive algorithm of finding the minimal eigenvector of a symmetric matrix was developed. These and other results are documented in the 15 journal publications, 17 conference papers, and 7 Ph.D. dissertations supported by this grant. GRA

**N87-29726#** South Dakota State Univ., Brookings.
**RF COMMUNICATIONS LABORATORY RENEWAL Technical Summary Report, Jul. 1984 - Jan. 1987**
Douglas B. Miron 8 Apr. 1987 23 p
(Grant AF-AFOSR-0241-84)
(AD-A183177; AFOSR-87-0702TR) Avail: NTIS HC A02/MF A01 CSCL 17B

This was an equipment purpose grant under the DOD-URIP program. The objective was to equip the RF Communications Laboratory to cover signal generation and measuring in the UHF band, and provide an antenna test facility. The necessary hardware was acquired, installed, and tested. The Lab is now functional. GRA

**N87-29727#** Pennsylvania Univ., Philadelphia. Dept. of Electrical Engineering and Science.
**SIGNAL PROCESSING AND ANALYSIS: STATISTICAL TECHNIQUES, EFFICIENT ALGORITHMS, NONLINEAR PROCESSING, EM ANALYSIS Final Technical Report, 15 Jul. 1984 - 14 Jul. 1985**
Saleem A. Kassam 27 Aug. 1986 22 p
(Grant AF-AFOSR-0255-84)
(AD-A183244; AFOSR-87-0943TR) Avail: NTIS HC A02/MF A01 CSCL 17B

A VAX 11/750 minicomputer and an image display and graphics controller and additional pieces of hardware were acquired. This

equipment has enabled the signal Processing Research Laboratory to be established at the University of Pennsylvania. GRA

**N87-29728#** Naval Postgraduate School, Monterey, Calif.
**MEASURED PROBABILITY DENSITY FUNCTION OF A PHASE-LOCKED LOOP (PLL) OUTPUT M.S. Thesis**
Mehmet Topcu Mar. 1987 80 p
(AD-A183334) Avail: NTIS HC A05/MF A01 CSCL 17B

The behavior of the Phase-Locked Loop (PLL) is difficult to describe analytically, especially when noise is present at the input because the system is non-linear. In this report, the noise behavior of the PLL is determined experimentally. Experimental results show that the probability density function of the PLL output for a variety of input signals which are each corrupted by additive Gaussian noise resembles the Gaussian density function. GRA

**N87-29729#** Mitre Corp., Bedford, Mass.
**FIBER OPTIC AND BROADBAND COAXIAL CABLE DATA NETWORK ALTERNATIVES FOR A FLYING MISSION BASE Final Report**
Robert M. Weigand May 1987 105 p
(Contract F19628-86-C-0001)
(AD-A183357; MTR-9891; ESD-TR-87-138) Avail: NTIS HC A06/MF A01 CSCL 17B

Air Force flying mission bases (strategic, tactical, and military airlift) require an upgraded and survivable data network to interconnect data processing equipment. The results of a comparative analysis of performance, survivability, and cost of fiber optic and coaxial cable data networks for this application are reported herein. The principal conclusion to be drawn from this work is that a fiber optic network offers survivability, reliability, and growth advantages at a cost comparable to an equivalent coaxial cable network. GRA

**N87-29730#** Army Engineer Topographic Labs., Fort Belvoir, Va.
**CLASSIFICATION OF SELECTED RADAR IMAGERY PATTERNS USING A BINARY TREE CLASSIFIER Research Note, Dec. 1983 - Sep. 1984**
Neil D. Fox Oct. 1986 32 p
(AD-A183370; ETL-0442) Avail: NTIS HC A03/MF A01 CSCL 17I

This report details the results of classifying radar imagery using a binary tree classifier. It was found that this classification algorithm works well with radar imagery, which would indicate a normal (Gaussian) feature vector distribution. The number of elements in each feature vector is the limiting factor, classification time is negligible once the tree structure has been created. GRA

**N87-29731#** Autometric Corp., Inc., Falls Church, Va.
**DEVELOPMENT OF COMPUTER VISION TECHNIQUES FOR AUTOMATIC FEATURE EXTRACTION Final Report, 1 Feb. 1986 - 15 Jan. 1987**
Daniel K. Gordon and Richard F. Pascucci 30 Jan. 1987 57 p
(AD-A183493; ETL-0451) Avail: NTIS HC A04/MF A01 CSCL 17E

In previous work, 52 descriptors (feature identifiers) and 501 descriptor sets were identified as being used by image analysts for the characterization of features found in radar imagery. In the research investigation described herein, the descriptor sets were tested and validated. Following this, computer vision techniques were identified and developed to automatically recognize these descriptor sets. The identification procedure includes image preprocessing (e.g., edge enhancement, density slicing, neighborhood encoding and thinning), raster to vector conversion, and the processing of the resultant vector data (e.g., identification of points, lines, and areas, referred to as primitives, including a description of primitive size, shape, position and orientation). Finally, the relative positions of primitives were examined, and the similarity between groups of primitives and descriptors that were identified in the previous work. The computer vision techniques that were developed have been demonstrated successfully, in a tightly controlled environment, on images containing little extraneous information. Research is currently being expanded to include carefully selected, uncluttered radar examples. The final goal of the investigation is the automatic identification of selected features from images acquired under a variety of conditions. GRA

**N87-29732#** Army Engineer Topographic Labs., Fort Belvoir, Va.
**PATTERN CLASSIFICATION TECHNIQUES APPLIED TO HIGH RESOLUTION, SYNTHETIC APERTURE RADAR IMAGERY**
Richard A. Hevenor and Pi-Fuay Chen Nov. 1986 31 p
(AD-A183537; ETL-0443) Avail: NTIS HC A03/MF A01 CSCL 17I

This report describes the application of 10 pattern classification techniques to selected samples of hign resolution, synthetic aperture radar imagery taken over the Huntsville, Alabama area. Sections of the radar imagery were digitized and stored on a digital disk unit. A Lexidata system 3400 image processor and a Hewlett Packard 1000 computer were used to display the images on a cathode ray tube and to take 100 samples for each of four terrain classes from the imagery. The 400 image samples were then used as training sets to derive the 10 classifiers. Once the classifiers were derived, the training set data were then used as input to the classifiers to see how well each would do in classifying the original training sets. GRA

**N87-29733#** Emmanuel Coll., Boston, Mass.
**MULTI-TECHNIQUE STUDY OF IONOSPHERIC STRUCTURES CAUSING DEGRADATION IN TRANS-IONOSPHERIC COMMUNICATIONS SYSTEMS Final Report, 3 Dec. 1983 - 31 Jan. 1987**
Sunanda Basu, Patricia Doherty, Eileen MacKenzie, and M. P. Hagan 20 Apr. 1987 116 p
(Contract F19628-84-K-0003)
(AD-A183542; AFGL-TR-87-0148) Avail: NTIS HC A06/MF A01 CSCL 20N

Multiple diagnostics have been used at different latitude regimes of the globe to probe large and small scale ionospheric structures which cause degradation in trans-ionospheric communication systems. It was determined that the equatorial anomaly crest had the most disturbed F-region irregularity environment giving rise to saturated GHz scintillation and phase scintillations as large as 16 radians at 244 MHz. At the magnetic equator a host of techniques during the Project Condor rocket campaign in Peru established that the largest GHz scintillations maximize in association with extended 3m backscatter plane structures and that speed-receiver scintillation measurements yield irregularity drift velocities in fairly good agreement with the 50 MHz radar interferometer drifts. By combining in-situ data of irregularities with scintillations, a new class of extended VHF scintillation producing irregularities was isolated known as bottomside sinusoidal. Author (GRA)

**N87-29734#** Booz-Allen and Hamilton, Inc., Bethesda, Md.
**ELECTROMAGNETIC PULSE (EMP) SURVIVABILITY OF TELECOMMUNICATIONS ASSETS Final Report**
6 Feb. 1987 150 p
(Contract DCA100-82-C-0034)
(AD-A183710; NCS-TIB-87-13) Avail: NTIS HC A07/MF A01 CSCL 20O

This report focuses on the estimation of the effects of EMP on selected telecommunications assets. The list of critical assets identified in previous reports is refined to reflect the proposed NETS network designs. The threat considered for the EMP effects evaluation is the 50 kV/m double exponential description of the early time portion of the high altitude EMP (HEMP) pulse which represents the most significant EMP threat to telecommunications assets. Intermediate time EMP and magnetohydrodynamic EMP (MHD EMP) effects are not explicitly evaluated. The report is also limited to typical installations of the selected assets; although versions of some equipment that have been explicitly hardened against EMP effects exist, these versions are not considered for this analysis. Author (GRA)

**N87-29518#** Hazeltine Corp., Greenlawn, N. Y. Adaptive Systems Lab.
**INCREASING THE USEFULNESS OF AWACS DOWNLINK TRANSMISSIONS BY SEMANTIC COMPRESSION**
Bonnie Schnitta-Israel and Roy S. Freedman *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 4 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29522#** National Aeronautical Establishment, Ottawa (Ontario).
**SPEECH IS MORE THAN JUST AN AUDIBLE VERSION OF TEXT**
Melvyn J. Hunt *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29523#** Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France).
**VOICE COMMAND AND THE CHANGE OF MENTAL REPRESENTATION DURING TASK PERFORMANCE [COMMANDE VOCALE ET CHANGEMENT DE REPRESENTATION MENTALE DANS LA TACHE]**
R. Amalberti, D. Batejat, and J.-P. Menu *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 10 p In FRENCH (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29524#** Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).
**LAYERED PROTOCOLS IN VOICE INTERACTION WITH COMPUTERS**
M. M. Taylor *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29525#** University of Southern California, Los Angeles. Dept. of Safety and Systems Management.
**THE ROLE OF ASYMMETRIC TRANSFER IN THE EVALUATION OF VOICE GENERATION AND RECOGNITION SYSTEMS**
D. L. Damos *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 8 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29528#** Institute for Perception RVO-TNO, Soesterberg (Netherlands).
**VOICE INTERACTIVE SYSTEMS IN SEVERE NOISE CONDITIONS**
J. H. M. Steeneken and G. Langhout *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 6 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29529#** Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
**EFFECT OF AUDIO BANDWIDTH AND BIT ERROR RATE ON PCM, ADPCM AND LPC SPEECH CODING ALGORITHM INTELLIGIBILITY**
Richard L. McKinley and Thomas J. Moore *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 7 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

# 33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

**N87-29735#** Varian Associates, Palo Alto, Calif.
**THE 140 GHz GYROTRON DEVELOPMENT PROGRAM Quarterly Report, Apr. - Jun. 1986**
K. L. Felch, R. E. Bier, L. J. Craig, R. L. Ives, H. R. Jory, N. C. Lopez, J. M. Neilson, S. T. Spang, and B. C. Stockwell 1986 55 p Prepared in cooperation with Lawrence Livermore National Lab., Calif.
(Contract W-7405-eng-48)
(DE87-010875; UCRL-15904; QR-9) Avail: NTIS HC A04/MF A01

The objective of this program is to develop a gyrotron oscillator capable of producing 100 kW CW at 140 GHz. Several sets of calculations are described characterizing the TE sub 021/TE sub 031 complex cavity used on Preprototype Tube 1. Initial design calculations for a new complex cavity design for Preprototype Tube 2 are summarized. Several analyses of the output window design were performed to improve agreement between calculated and meaured temperature data and to investigate the behavior of the window design at higher power levels. The results of these analyses are reported. Long-pulse and CW tests on Preprototype Tube 1 were carried out. During these tests, a CW power level of 100 kW was obtained, thus meeting the major technical goal of the 140 GHz Gyrotron Development Program. Long-pulse tests resulted in the achievement of a power level of 150 kW during 100 ms pulse operation. Additional short-pulse tests yielded power levels in excess of 200 kW. The results of the various tube tests on Preprototype Tube 1 are described and compared to theoretical predictions where possible. Initial tube tests on the rebuild of Experimental Tube 1 are summarized. DOE

**N87-29736#** Sandia National Labs., Albuquerque, N. Mex.
**EXPLORATORY BATTERY TECHNOLOGY DEVELOPMENT AND TESTING REPORT FOR 1985**
N. J. Magnani, R. P. Clark, J. W. Braithwaite, D. M. Bush, P. C. Butler, J. M. Freese, K. R. Grothaus, K. D. Murphy, and P. E. Shoemaker Jun. 1987 116 p
(Contract DE-AC04-76DP-00789)
(DE87-012505; SAND-86-1266) Avail: NTIS HC A06/MF A01

Sandia National Laboratories, Albuquerque, has been designated as Lead Center for the Exploratory Battery Technology Development and Testing Project, which is sponsored by the US DOE's Office of Energy Storage and Distribution. In this capacity, Sandia is responsible for the engineering development of advanced rechargeable batteries for both mobile and stationary energy storage applications. This report details the technical achievements realized in pursuit of the Lead Center's goals during calendar year 1985. They are divided into: aqueous battery development, nonaqueous battery development, battery technology evaluation, technology improvement, and project analysis. DOE

**N87-29737*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**A DIGITALLY CONTROLLED SYSTEM FOR EFFECTING AND PRESENTING A SELECTED ELECTRICAL RESISTANCE Patent Application**
15 Jul. 1987 16 p
(NASA-Case-MFS-29149-1; NAS 1.71:MFS-29149-1;
US-Patent-Appl-SN-073541) Avail: NTIS HC A02/MF A01
CSCL 09C

A digitally controlled resistance generator is described, in which resistors having values selected according to an expression 2 sup N-1 sub (R), where N is equal to the number of terms in the expression, and R is equal to the lowest value of resistance, are electrically inserted into a resistive circuit in accordance with a

parallel binary signal provided by an analog-to-digital converter or a programmable computer. This binary signal is coupled via optical isolators which, when activated by a logical 1, provides a negative potential to some or all of the gate inputs of the normally on field effect transistors which, when on, shorts out the associated resistor. This applied negative potential turns the field effect transistors off and electrically inserts the resistor coupled between the source terminal and the drain terminal of that field effect transistor into the resistive circuit between the terminals. NASA

**N87-29738*#** General Dynamics Corp., San Diego, Calif. Space Systems Div.
**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT TEST PROGRAM Contractor Report, Jun. 1981 - Nov. 1985**
Loran J. Wappes Oct. 1986 243 p
(Contract NAS3-22777)
(NASA-CR-175069-Vol-1; NAS 1.26:175069-Vol-1) Avail: NTIS HC A11/MF A01 CSCL 09C

Proof-of-concept testing was performed on a 20-kHz, resonant power system breadboard from 1981 through 1985. The testing began with the evaluation of a single, 1.0-kW resonant inverter and progressed to the testing of breadboard systems with higher power levels and more capability. The final breadboard configuration tested was a 25.0-kW breadboard with six inverters providing power to three user-interface modules over a 50-meter, 20-kHz bus. The breadboard demonstrated the ability to synchronize multiple resonant inverters to power a common bus. Single-phase and three-phase 20-kHz power distribution was demonstrated. Simple conversion of 20-kHz to dc and variable-frequency ac was demonstrated as was bidirectional power flow between 20-kHz and dc. Steady state measurements of efficiency, power-factor tolerance, and conducted emissions and conducted susceptibility were made. In addition, transient responses were recorded for such conditions as start up, shut down, load changes. The results showed the 20-kHz resonant system to be a desirable technology for a spacecraft power management and distribution system with multiple users and a utility-type bus. Author

**N87-29739*#** General Dynamics Corp., San Diego, Calif. Space Systems Div.
**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT TEST PROGRAM, VOLUME 2, APPENDIX 1 Final Report**
Oct. 1986 523 p
(Contract NAS3-22777)
(NASA-CR-175069-Vol-2; NAS 1.26:175069-Vol-2) Avail: NTIS HC A22/MF A01 CSCL 09C

This report contains two volumes. The main text (Volume 1) summarizes the tests results and gives a detailed discussion of the response of three early, first generation configurations of ac power system IRAD breadboards to the contracted tests imposed on them. It explains photographs, measurements, and data calculations, as well as any observed anomalies or lessons learned. This volume (No 2, Appendix 1, Test Results and Data), published under separate cover, includes all of the data taken on the 1.0 kW single-phase; 5.0 kW three-phase; and 25.0-kW three-phase system breadboards. The format of this data is raw, i.e., it is a direct copy of the data sheets for the test data notebook. Author

**N87-29740#** Public Service Electric and Gas Co., Newark, N. J.
**BATTERY ENERGY STORAGE TEST (BEST) FACILITY Final Summary Report, 1976-1986**
E. A. Hyman Dec. 1986 47 p Prepared in cooperation with EPRI, Palo Alto, Calif.
(Contract DE-AC02-76ET-29368; EPRI Proj. 255-2)
(DE87-004785; EPRI-AP-4982) Avail: NTIS HC A03/MF A01

This report summarizes the development, operations, and contributions of the Battery Energy Storage Test Facility. Providing direction for the nation's battery technology research, the facility has generated a better understanding of the work involved in operating energy storage systems and has been instrumental in demonstrating lead-acid battery applications for utilities worldwide. DOE

**N87-29741#** Sandia National Labs., Albuquerque, N. Mex.
**GASEOUS CONTAMINANTS MODIFY THE FRICTION AND WEAR RESPONSE OF PRECIOUS METAL ELECTRICAL CONTACT ALLOYS**
L. E. Pope and D. E. Peebles 1987 28 p Presented at the 33d IEEE/Holm Conference, Chicago, Ill., 21 Sep. 1987
(Contract DE-AC04-76DP-00789)
(DE87-007862; SAND-86-2796C; CONF-870960-1) Avail: NTIS HC A03/MF A01

An in-situ electrical contact resistance and friction coefficient measuring device has been installed in a scanning Auger microprobe. A pin-on-plate experimental configuration is used. This tribology system has been used to characterize the friction, wear and electrical contact resistance of a Pd alloy pin (ASTM B540) sliding on a Au alloy plate (ASTM B541). Studies have been completed with and without H2S in the atmosphere for wear in 1.6 x 10 to the -6 torr O2, 700 torr of 5% O2 in N2 and 700 torr He. The presence of H2S reduces the friction coefficient and decreases the wear track width on the Au alloy. The lower friction is associated with adsorption and reaction of the H2S with the Au alloy plate. In the ambients containing H2S, large accumulations of S in wear tracks are observed; however, no increase in the electrical contact resistance occurs. In the 700 torr ambients containing H2S, Cu segregates to the wear track surfaces to the exclusion of the other metallic elements and forms Cu2S layers. A concomitant shift occurs in the S and Cu Auger peak positions when the Cu2S film thickens. DOE

**N87-29742#** Sandia National Labs., Albuquerque, N. Mex.
**DEVELOPMENT AND PROCESS CONTROL FOR RIGID/FLEX, MULTILAYER PRINTED WIRING BOARDS**
F. L. Gentry Aug. 1987 24 p
(Contract DE-AC04-76DP-00789)
(DE87-012845; SAND-86-1555) Avail: NTIS HC A02/MF A01

Rigid/flex multilayers require certain unique processing parameters not common to conventional printed wiring products: special machining of windows, the use of no-flow prepreg adhesives, plasma etching of nonhomogeneous material compositions, and more stringent plating controls. Performance of these products can be predicted by modeling studies and verified by physical testing. Thermophysical characteristics are described as well as the establishment of rigid/flex capabilities in a development laboratory. The actual fabrication processing steps are also described for high-reliability, six-layer rigid/flex boards whose two center layers are flexible circuitry. DOE

**N87-29743#** Sandia National Labs., Albuquerque, N. Mex.
**REPETITIVELY PULSED VACUUM INSULATOR FLASHOVER**
J. W. Ginn and M. T. Buttram 1987 16 p Presented at the 6th Institute of Electrical and Electronic Engineers Pulsed Power Conference, Arlington, Va., 29 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-011196; SAND-86-2924C; CONF-870656-8) Avail: NTIS HC A02/MF A01

Experiments were performed to determine the flashover strength of various vacuum insulators under conditions of repetitive pulsing. The pulse duration was 30 ns, and the thickness of a typical insulator sample was 1.8 cm. Data were taken for 45 deg insulators from five different materials. An insulator was subjected to an extended series of pulses at a given repetition rate and field. If flashover was not detected, the field level was increased and the sequence repeated. At rates up to 50 pulses per second, there was no apparent dependence of flashover field on rate. In addition, some single shot data were taken, including various modifications of the geometries and surface textures of the insulators. Only two of the modifications increased the flashover strength significantly over that of a 45 deg sample: (1) annealing some plastics (roughly a 35% increase), and (2) extending the insulator to cover the surfaces of both electrodes (an increase of nearly a factor of two). DOE

**N87-29744#** Sandia National Labs., Albuquerque, N. Mex.
**DIELECTRIC MODIFICATION OF REPETITION-RATE TESTED POLYCARBONATE-PERFLUOROCARBON CAPACITORS: THE G. H. MAULDIN MEMORIAL REPORT**
G. H. Mauldin, M. C. Thompson, R. B. Somoano, S. P. S. Yen, J. O. Harris, and E. T. Schreiner 1987 11 p Presented at the 6th Institute of Electrical and Electronic Engineers Pulsed Power Conference, Arlington, Va., 29 Jun. 1987 Prepared in cooperation with Los Alamos National Lab., N. Mex. and JPL, California Inst. of Technology, Pasadena
(Contract DE-AC04-76DP-00789)
(DE87-011306; SAND-87-1698C; CONF-870656-7) Avail: NTIS HC A02

It appears the operational life of a perfluorocarbon-impregnated capacitor is a strong function of the crystalline-amorphous character of the polycarbonate (PC) dielectric material. X-ray diffraction studies and thermomechanical analysis (TMA) of the material at the Jet Propulsion Laboratory, Pasadena, California, have shown new enlightening information. Gas Studies of the impregnate solution have also yielded new answers. Discussed is the dynamics of both the ESR (equivalent series resistance) and the equivalent dynamic capacitance of an in-situ device as observed during testing at the Los Alamos National Laboratory's test facility. DOE

**N87-29745#** Los Alamos National Lab., N. Mex.
**ANALYSIS AND INTERPRETATION OF ac IMPEDANCE DATA FOR POROUS ELECTRODES**
T. E. Springer and I. D. Raistrick 1987 15 p Presented at the 171st Electrochemical Society Meeting, Philadelphia, Pa., 10 May 1987
(Contract W-7405-eng-36)
(DE87-013143; LA-UR-87-2285; CONF-870560-4) Avail: NTIS HC A02

Ac impedance spectroscopy has been used to measure the dynamic response of two types of porous gas-diffusion oxygen electrodes in a sulfuric acid electrolyte. Models were developed based on flooded and on thin-film pore structure. The transfer functions of these structures were calculated and the impedance result fitted to the models using a nonlinear least squares program. The results were used to assess the adequacies of the models. DOE

**N87-29746#** Siemens A.G., Heidenheim (West Germany). Unternehmensbereich Bauelemente.
**INTEGRATED CIRCUIT CHIP WITH INTEGRATED PLASTIC THIN FILM CAPACITOR Final Report, Dec. 1985**
Juergen Fetzer, Franz Schadt, Rudolf Wittmann, Albert Fischer, Heinrich Goeke, Hartmut Michel, and Johann Kammermaier Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 71 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung and Technologie, West Germany
(BMFT-FB-T-86-151; ISSN-0340-7608; ETN-87-90337) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 15

A capacitor located directly on the integrated circuit (IC) was developed using plasma polymerization and sputtering of aluminum, for miniaturization in solid state techniques, combined with decreasing operating voltages and increasing switching frequencies. Electrical contact between IC pad and capacitor was achieved by conducting tracks. The capacitor size can be neglected. A capacitor with an organic dielectric, as well as reliable electrical contact and sufficient resistance against heat and moisture was developed in the following steps: setting up of a cooled electrode system for plasma polymerization with a specific gas distribution; development of a monomer gas mixture of hydrocarbons and perfluorated hydrocarbons, and introduction of defined tempering cycles and of an aperture concept which resulted in a high amount of electrode and dielectric layers. ESA

**N87-29747#** Bristol Univ. (England). Dept. of Electrical Engineering.
**THE HALF-SPEED LINEAR MACHINE: A NEW FORM OF LINEAR SYNCHRONOUS MOTOR Ph.D. Thesis**
Abde-Karim Manuk Feb. 1986 241 p Sponsored by Aleppo Univ., Syria
(ETN-87-90708) Avail: NTIS HC A11/MF A01

The behavior of an unorthodox form of linear synchronous induction machine is investigated in asynchronous and synchronous modes. The machine is inherently brushless, its single stator winding being fed with alternating and direct current for synchronous operation. The machine was studied because of the prospect it offered of controllable power factor. A mathematical model based on the two axis theory which is appropriate to the segmental form of construction of its secondary winding is developed. The model enables a critical assessment to be made of its performance particularly with regard to important machine circuit parameters. Experiments on an experimental machine confirm model validity. Notwithstanding the relatively high resistance and leakage parameters of the trial machine, the possibility of good performance, including high power factor, obtainable in larger sizes is demonstrated. ESA

**N87-29748#** Bristol Univ. (England). Dept. of Electrical Engineering.
**SPEED-CHANGING OF INDUCTION METHODS BY PHASE MODULATION Ph.D. Thesis**
Kais S. Ismail Jan. 1986 224 p Sponsored by Baghdad Univ., Iraq
(ETN-87-90709) Avail: NTIS HC A10/MF A01

The principle of phase modulation is described and methods of design which enable speed-changing of induction motors to be achieved using six-lead changeover switching are developed. Comparison with the method of pole amplitude modulation (PAM) shows that the developed method is superior. The method of switching, however, requires three parallel-path connections for three-phase windings and this places practical limitations on their design. Nevertheless windings which, for constant-torque or constant-power close-ratio speed-changing, are to be preferred to PAM were designed. The methods of design are applied to a variety of pole-combinations. Trial machines for the popular pole-combinations of 8/10, 4/6, and 6/4 poles were built and tested. Their successful operation confirms the value of the application of phase modulation. ESA

**N87-29749#** Bristol Univ. (England). Dept. of Electrical Engineering.
**PWM STRATEGIES FOR MICROPROCESSOR CONTROL OF VARIABLE SPEED DRIVES Ph.D. Thesis**
Abdel Hamid Midoun Dec. 1985 407 p Sponsored by the Algerian Ministry of Higher Education
(ETN-87-90714) Avail: NTIS HC A18/MF A01

Pulse width modulation (PWM) strategies suitable for inverter based systems are presented. Sinusoidal moduiation is reviewed showing the superiority of regular asymmetric sampling over regular symmetric and natural sampling. Results concerning harmonic current minimization, harmonic torque minimization, and harmonic elimination techniques are presented. A technique to develop PWM strategies where different performance criteria are combined is outlined. A modulation process which approximates the characteristics of the harmonic current minimization is given. A method to switch from the PWM mode to the quasi square wave mode with reduced harmonic distortion and negligible transient phenomena is shown. ESA

**N87-29750*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**DETECTION OF RADIO-FREQUENCY MODULATED OPTICAL SIGNALS BY TWO AND THREE TERMINAL MICROWAVE DEVICES**
K. B. Bhasin, R. N. Simons, and S. Wojtczuk (Cornell Univ., Ithaca, N.Y.) 1987 11 p Presented at the 1987 Technical Symposium on Optics, Electro-Optics and Sensors, Orlando, Fla., 17-22 May

1987; sponsored by the Society of Photo-Optical Instrumentation Engineers
(NASA-TM-100196; E-3698; NAS 1.15:100196) Avail: NTIS HC A02/MF A01 CSCL 09C

An interdigitated photoconductor (two terminal device) on GaAlAs/GaAs heterostructure was fabricated and tested by an electro-optical sampling technique. Further, the photoresponse of GaAlAs/GaAs HEMT (three terminal device) was obtained by illuminating the device with an optical signal modulated up to 8 GHz. Gain-bandwidth product, response time, and noise properties of photoconductor and HEMT devices were obtained. Monolithic integration of these photodetectors with GaAs microwave devices for optically controlled phased array antenna applications is discussed. Author

**N87-29751#** Colorado Univ., Boulder.
**SUPERIONIC CONDUCTOR REPETITIVE OPENING SWITCHES FOR ADVANCED PULSE POWER Annual Report, 1 Jul. 1986 - 30 Jun. 1987**
James F. Scott 30 Jun. 1987 9 p
(Contract N00014-86-K-0516)
(AD-A182919; Rept-153-4705) Avail: NTIS HC A02/MF A01 CSCL 20C

The initial phase of investigation has been completed to analyze an unusual photo-electric effect in the superionic conductor silver iodide tungstate (Ag13I9W2O8). This material exhibits a sharp decrease in electrical conductivity upon illumination with laser light (in contrast to the increase observed for all other known materials), which suggests its potential use as a very fast, repetitive opening switch. Work this year reveals a previously unknown aging process that may preclude commercial development of such an opening switch. This was independently discovered by Suthanthiraraj this year (Bull. Electrochem. 2, 553 (1986). In the dark, the power drops by 84% after 125 days, when utilized as a battery; similar degradation occurs for use as a switch. The presence of laser light greatly accelerates the aging. A very fast all-operational-amplifier circuit has been designed and fabricated to measure optical response of this material; however, the need to use fresh samples for reproducible results complicates the program. GRA

**N87-29752#** Naval Research Lab., Washington, D.C.
**PERMITTIVITY MEASUREMENTS UTILIZING THE DIELECTRIC POST IN WAVEGUIDE TECHNIQUE Interim Report**
Frederic J. Rachford 9 Jul. 1987 82 p
(AD-A183327; NRL-MR-6014) Avail: NTIS HC A05/MF A01 CSCL 09A

This report describes experimental procedures and computer codes for the measurement of the permittivity of filamentary high loss materials by the dielectric post-in-waveguide (DPW) technique. This method is especially useful in characterizing the microwave/millimeter wave dielectric properties of materials such as partially graphitized carbon fibers, linear chain crystals, superionic conductors, ferroelectrics, etc. This method allows the complex permittivity, to be measured on a pointwise continuous frequency basis across a rectangular waveguide band. We have employed and will describe two measurement setups; for X and Ku band studies we have collected data with commercial automated vector network analyzers, for K and Ka bands we have assembled transmission phase bridges using standard waveguide components and a scalar network analyzer. The computer codes developed for this work are described in detail and selected programs and subroutines are listed in the appendix. GRA

**N87-29753#** Naval Research Lab., Washington, D.C.
**THEORY OF CROSS FIELD DEVICES AND A COMPARATIVE STUDY OF OTHER RADIATION SOURCES**
Y. Y. Lau 21 Jul. 1987 71 p
(AD-A183389; NRL-MR-6029) Avail: NTIS HC A04/MF A01 CSCL 09A

An elementary exposition of the theory of cross field microwave devices is given. It provides an examination of the interaction mechanism in the light of the more modern radiation sources such as orbitron, gyrotron, peniotron and gyromagnetron. The operating conditions of magnetrons are described, together with a qualitative description of the physical processes by which the energy of the electrons is transferred to the RF. These processes involve an interplay of the streaming motion and transverse migration of the electrons in dc electric and magnetic fields, and phase focusing provided by the RF fields of the corrugated walls. The essential features of the interaction mechanism can be quantified by the use of a sheet beam model and the various radiation sources are then characterized by a single dimensionless parameter (h), which is proportional to the equilibrium electric field experienced by the sheet beam. The wall corrugation enters only in the admittance in the theory of beam-wave interaction. A small signal theory is developed from first principle for general values of h. The decisive dependence of the stability on the equilibrium type (h) is described in detail. While the validity of the simple theory has been ascertained by various vigorous tests, several important features remain to be tested in laboratory experiments. These, together with other outstanding issues, will be addressed. GRA

**N87-29754#** Cornell Univ., Ithaca, N.Y. School of Electrical Engineering.
**STUDY AND DEVELOPMENT EFFORT ON OPPOSED GATE-SOURCE GaAs DEVICES Final Report, Sep. 1983 - Jun. 1986**
Lee K. Rauschenbach, J. Bellantoni, G. C. Dalman, H. Kondoh, and A. Yarborough May 1987 194 p
(Contract N66001-83-C-0363; ARPA Order 4766)
(AD-A183433; NOSC-TD-1092) Avail: NTIS HC A09/MF A01 CSCL 09A

This document describes research on the Opposed Gate-Source Transistor (OGST) for the millimeter wave regime. Progress described concerns the development of self aligned lithography processes for fabricating a source contact opposite the gate electrode on a 200 nm GaAs membrane, the processing an ohmic source contact, the fabrication of a Schottky gate contact compatible with the high temperature processing of the source contact, and the electrical characterization of the transistors. GRA

**N87-29755#** Stanford Univ., Calif. Center for Reliable Computing.
**AN EXPERIMENT ON INTERMITTENT-FAILURE MECHANISMS**
Mario L. Cortes and Edward J. McCluskey Mar. 1987 43 p
(Contract N00014-85-K-0600)
(AD-A183572; CRC-TR-87-7; CSL-TR-87-322) Avail: NTIS HC A03/MF A01 CSCL 09A

Intermittent failures are studied by stressing (temperature, supply voltage and extra loading) good parts. The behavior of the chips under stress is similar to that of a marginal chip under normal operating conditions. The experiments show that most intermittent failures are pattern-sensitive for both sequential and combinational circuits. The stuck-at fault model is shown to be inappropriate to describe intermittent failures. This paper presents a case where a single intermittent failure is not detected by a test set with 100% single stuck-at fault coverage. A stress-strength analysis is presented to explain the experimental results. GRA

**N87-29756#** Naval Postgraduate School, Monterey, Calif.
**DIGITALLY PROGRAMMABLE ACTIVE SWITCHED CAPACITOR FILTERS M.S. Thesis**
Cengiz Yalkin Mar. 1987 89 p
(AD-A183596) Avail: NTIS HC A05/MF A01 CSCL 09A

Analog active circuits are analyzed and designed using periodic sampling techniques. Switched capacitor networks are the basis of these techniques. The use of switched capacitor network allows active filters to be implemented in IC form. As an application, a general purpose digitally controlled analog sampled data filter is presented. The results of this programmable filter are compared with the computer simulations for theoretical and practical verifications. The final goal of this research is to demonstrate a

number of practical conclusions about switched capacitor networks. GRA

**N87-29757#** Minnesota Univ., Minneapolis. Dept. of Chemical Engineering and Mateials Science.
**APPLICATIONS OF MULTIVALENT IONIC CONDUCTORS TO POLYMERIC ELECTROLYTE BATTERIES Technical Report, Sep. 1986 - Aug. 1987**
J. Y. Cherng, B. B. Owens, W. H. Smyrl, and M. Z. Munshi Jul. 1987 4 p
(Contract N00014-85-K-0634)
(AD-A183707; TR-8) Avail: NTIS HC A02/MF A01 CSCL 10C

Fast ion conduction has been demonstrated in certain polymer materials doped with an alkali metal salt. Recently divalent salts have also been used in the preparation of ionically conducting polymers. Certain complexes were found to be anion conductors while others were cation conductors. It is therefore of interest to study the reasons for the apparent difference. Alternating current measurements are currently being evaluated on a number of polymer divalent salt complexes. Electrochemical cells are being constructed with appropriate cathodes to assess the feasibility of these polymer electrolytes in rechargeable batteries. GRA

**N87-29758#** Massachusetts Univ., Amherst. Dept. of Electrical and Computer Engineering.
**FAULT-TOLERANT MULTIPROCESSOR AND VLSI-BASED SYSTEMS Final Report, Jan. 1984 - Jan. 1987**
Dhiraj K. Pradhan 15 Mar. 1987 73 p
(Grant AF-AFOSR-0052-84)
(AD-A183820; AFOSR-87-0901TR) Avail: NTIS HC A04/MF A01 CSCL 09A

Study and development of certain fault-tolerant architectures that utilize the capabilities of new IC technology was undertaken. Specifically, the research was aimed at network architectures, distinguished by a close interconnection of a large number of computing elements. Included is a subclass of specialized network architectures known as VLSI processor arrays. Besides fault-tolerance-related research for such arrays, also proposed was exploration of a new array architecture, developed for the express purpose of executing general algorithms on these arrays. The precise research formulated-developing fault-tolerant multiprocessor network architectures-goes beyond earlier work. Here, the system interconnection structure, itself, was used as the primary design tool for achieving various and diverse objectives, including: low inter connection and layout complexities, dynamic reconfigurability, fault-tolerance through graceful degradation as well as self-diagnosability. Viability of the proposed research was demonstrated in the proposal. New communication structures were introduced, along with concepts of admissability of multiple logical configurations, and algorithmic and detour routing that provide fault-tolerance and graceful degradation. GRA

**N87-29759#** Minnesota Univ., Minneapolis. Corrosion Research Center.
**THE OVERCHARGE AND OVERDISCHARGE BEHAVIOR OF POLYMER ELECTROLYTE CELLS Technical Report No. 11, Sep. 1986 - Aug. 1987**
R. Gopaliengar, M. Z. Munshi, and Boone B. Owens Jul. 1987 4 p
(Contract N00014-85-K-0634)
(AD-A183838) Avail: NTIS HC A02/MF A01 CSCL 10C

The overcharge and overdischarge behavior of the cell Li/(PEO)8 LiCF3SO3/V6O13 is being investigated with particular emphasis on the changes taking place at the cathode. Cells placed on overcharge have shown an inability to discharge. Optical microscopy has revealed severe electrolyte and cathode degradation with the presence of white fluffy deposits located at the cathode-electrolyte interface. This was shown by EDAX analysis to be predominantly rich in salt. Vanadium was also detected at the Li-electrolyte interface. GRA

**N87-29760#** Minnesota Univ., Minneapolis. Corrosion Research Center.
**OPTIMIZATION AND SCALE-UP PERFORMANCES OF POLYMER ELECTROLYTE BATTERIES Technical Report No. 10, Sep. 1986 - Aug. 1987**
M. Z. Munshi and Boone B. Owens Jul. 1987 4 p
(Contract N00014-85-K-0634)
(AD-A183841) Avail: NTIS HC A02/MF A01 CSCL 10C

The rechargeable high energy density polymer electrolyte battery utilizing a lithium anode, poly(ethylene oxide)-salt complex electrolyte and vanadium oxide composite cathode is being investigated in this laboratory. Cycled tests indicated good adhesion at the anode/electrolyte and electrolyte/cathode interfaces, even after one-hundred deep cycles. Results are also presented on the morphological changes taking place at the cathode. A modified polymer electrolyte with relatively higher room temperature ionic conductivity has also been employed in cells at ambient temperatures. Scaled-up designs are under evaluation. GRA

**N87-29761#** Aerospace Corp., El Segundo, Calif. Chemistry and Physics Lab.
**OXYGEN EVOLUTION KINETICS AT POROUS NICKEL ELECTRODES**
Albert H. Zimmerman and Peter K. Effa 3 Aug. 1987 27 p
(Contract F04701-85-C-0086)
(AD-A183884; TR-0086(6945)-4; SD-TR-87-44) Avail: NTIS HC A03/MF A01 CSCL 09A

The impedance of porous nickel electrodes has been measured under conditions of steady-state oxygen evolution. Significant effects are observed due to the pore structure of the electrodes, and these effects are found to correlate with loading levels, performance, and composition. The oxygen evolution characteristics of sintered plate electrodes have been investigated as a convenient means for determining the structural uniformity and the overall quality of such plates for use as battery electrodes. GRA

**N87-29762#** David Sarnoff Research Center, Princeton, N.J.
**DUAL-GATE FET (FIELD EFFECT TRANSISTOR) AMPLIFIER SWITCH, TASK 1 Final Report, 1 Jan. 1983 - Dec. 1986**
Daniel D. Mawhinney 15 Feb. 1987 39 p
(Contract N00039-83-C-0131)
(AD-A183924) Avail: NTIS HC A03/MF A01 CSCL 09A

A gallium-arsenide dual-gate field effect transistor amplifier-switch was designed and fabricated to provide an improved means for generating a high-speed microwave pulse from a CW source to simulate an actual radar pulse. Fast rise and fall time capabilities were demonstrated by the FET amplifier-switches which provided an on-off ratio of more than 50-dB. Descriptions of the FET amplifier-switches are provided along with specific test results over the 7 to 11 GHz frequency range. GRA

# 34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

**N87-29763*#** Tennessee Univ. Space Inst., Tullahoma.
**FINITE ELEMENT SOLVER FOR 3-D COMPRESSIBLE VISCOUS FLOWS Interim Report, Apr. - Oct. 1986**
K. C. Reddy and J. N. Reddy Dec. 1986 35 p
(Contract NAS8-36555)
(NASA-CR-179182; NAS 1.26:179182) Avail: NTIS HC A03/MF A01 CSCL 20D

The space shuttle main engine (SSME) has extremely complex internal flow structure. The geometry of the flow domain is three-dimensional with complicated topology. The flow is compressible, viscous, and turbulent with large gradients in flow

quantities and regions of recirculations. The analysis of the flow field in SSME involves several tedious steps. One is the geometrical modeling of the particular zone of the SSME being studied. Accessing the geometry definition, digitalizing it, and developing surface interpolations suitable for an interior grid generator require considerable amount of manual labor. There are several types of grid generators available with some general-purpose finite element programs. An efficient and robust computational scheme for solving 3D Navier-Stokes equations has to be implemented. Post processing software has to be adapted to visualize and analyze the computed 3D flow field. The progress made in a project to develop software for the analysis of the flow is discussed. The technical approach to the development of the finite element scheme and the relaxation procedure are discussed. The three dimensional finite element code for the compressible Navier-Stokes equations is listed. B.G.

**N87-29764** ESDU International Ltd., London (England).
**FLUID TRANSIENTS IN PIPES. USE OF AIR INLET/OUTLET VALVES AS SURGE SUPPRESSION DEVICES**
May 1985 57 p
(ESDU-85009; ISBN-0-85679-515-1; ISSN-0141-4011) Avail: ESDU

This Data Item #85009, an addition to the Fluid Mechanics, Internal Flow Sub-series, gives a graphical means of estimating the maximum mass inflow rate, and hence the pressure drop below atmospheric, through an air inlet/outlet valve following pump trip or valve closure. The maximum volume of air in the resulting air cavity is also predicted, and hence the time taken for the air to be released on restarting the line. The method assumes a constant diameter liquid-filled line carrying fluid from an upstream sump to a downstream constant pressure point. A program in BASIC is also given to provide the information, and covers the case when the line is additionally protected by an air vessel. The use of the information is illustrated in a practical worked example. Guidance on the use and location of air valves in pipelines for both normal use and surge suppression is included. ESDU

**N87-29765** Toronto Univ. (Ontario). Inst. for Aerospace Studies.
**COMPUTATION OF TURBULENT FREE ISOTHERMAL SWIRLING JETS**
R. A. Cusworth and J. P. Sislian Jan. 1987 147 p
(UTIAS-315; ISSN-0081-5255) Copyright Avail: Issuing Activity

Previously, all of the mean velocity components and Reynolds stresses were measured in free swirling and non-swirling jets with a one dimensional LDV system. A comparison between the measured and calculated values obtained from the standard Kappa-epsilon model and modified forms of it is presented. Three cases are studied: non-swirling, weak swirling, and swirling recirculating free jets. The modification as described by Launder, Morse, Rodi, and Spalding for the non-swirling jet, compared well with experimental values of the mean axial velocity but no so well with the turbulence kinetic energy. As for the swirling jets, Leschziner and Rodi's modified model showed promise in the weak swirl jet but requires improvement for the recirculating flow. The standard kappa-epsilon model by contrast, compared well with the mean axial velocity in the recirculating flow but not so well for the weak swirling flow. Launder, Priddin, and Sharma's modified model needs improvement in both situations. Author

**N87-29766#** Naval Surface Weapons Center, Silver Spring, Md.
**NUMERICAL SOLUTIONS FOR LAMINAR FLOW OVER A BACKWARD-FACING STEP**
W. G. Szymczak, J. M. Solomon, A. E. Berger, J. B. Bell, and J. E. Osborn Jun. 1987 10 p Presented at the 6th IMACS International Symposium on Computer Methods for Partial Differential Equations, Bethlehem, Pa., 23 Jun. 1987 Prepared in cooperation with Lawrence Livermore National Lab., Calif.; Maryland Univ., College Park
(Contract W-7405-eng-48)
(DE87-010782; UCRL-96763; CONF-870677-7) Avail: NTIS HC A02

In this paper, we present numerical results for steady two-dimensional laminar flow over a rearward facing step. This problem is special in the sense that the use of conservative central differencing of the convective terms does not generate spurious oscillations in the flowfield, even when the cell Reynolds number condition is violated. However, spurious oscillations do appear when considering either the problem of flow over a full step or flow in a smoothly expanding channel. A scheme in which artificial viscosity is added primarily in the flow direction is shown to be more stable than the central difference scheme, without the loss of accuracy associated with certain first order upwind schemes. These computational results are compared to the experimental measurements of Armaly et al., on the rearward facing step problem. The accuracy of these schemes as well as several others appearing in the literature are also tested on two model convection diffusion problems. DOE

**N87-29767#** Sandia National Labs., Albuquerque, N. Mex.
**A NUMERICAL STUDY OF RAYLEIGH-TAYLOR INSTABILITY IN SOLIDS**
J. W. Swegle 1987 4 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-011319; SAND-87-0773C; CONF-870753-3) Avail: NTIS HC A02/MF A01

In an effort to better understand the phenomenon of the growth of Rayleigh-Taylor instabilities in solids, a numerical study using a Lagrangian finite-difference wavecode has been done to determine the influence of various parameters including perturbation amplitude and wavelength, material yield strength, and driving pressure history. Results have been correlated with experimental data on aluminum, and with current analytical modeling efforts. More complex behavior is seen than predicted by earlier analytical treatments found in the literature. Rather than simple stability criteria based amplitude or wavelength alone, it is found that there are yield strength and driving pressure dependent boundaries between stable and unstable regions in the amplitude-wavelength plane. Also, different behavior is seen for increasing driving pressure than for constant driving pressure. DOE

**N87-29768#** Sandia National Labs., Albuquerque, N. Mex.
**MODELING OF SHOCK-INDUCED SOLID STATE CHEMISTRY**
Y. Horie and M. E. Kipp Jun. 1987 40 p
(Contract DE-AC04-76DP-00789)
(DE87-011578; SAND-86-2874) Avail: NTIS HC A03/MF A01

This report, a sequel to Sandia Report 86-0922 entitled, Shock-Induced Solid State Chemistry: Theoretical Background, by Y. Horie, describes models of chemical reactions in inorganic powder mixtures under high pressure shock wave loading. In the present work, two mathematical models, one homogeneous and the other heterogeneous, were formulated based mostly upon existing results of observations on post-shock samples of Al-Ni, Al-Ti, and ZnO-Fe2O3 mixtures. Two basic mechanisms were isolated for the development of the initial models: (1) the creation of a nonequilibrium mixture by dynamic mass mixing, and (2) ensuing chemical reactions. The homogeneous model was evaluated under shock conditions using the one dimensional wave propagation code WONDY-V. We found that results of recent measurements can be rationalized by the model. The model also suggested requisite conditions for the thermal excursion of localized reactions: a localized initial peak temperature of 1000K to 2000K and reaction time constants of 1 microsec or less. Evidence that reactions occurred while the sample was under shock loading may also be rationalized by observations of post-shock samples. DOE

**N87-29769*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**CAPILLARY HEAT TRANSPORT AND FLUID MANAGEMENT DEVICE Patent Application**
James W. Owen, inventor (to NASA) 30 Jun. 1987 18 p
(NASA-Case-MFS-28217-1; NAS 1.71:MFS-28217-1; US-Patent-Appl-SN-067844) Avail: NTIS HC A02/MF A01

(NASA-Case-MFS-28217-1; NAS 1.71:MFS-28217-1; US-Patent-Appl-SN-067844) Avail: NTIS HC A02/MF A01

A passive heat transporting and fluid management apparatus including a housing in the form of an extruded body member having flat upper and lower surfaces is disclosed. A main liquid channel and at least two vapor channels extend longitudinally through the housing from a heat input end to a heat output end. The vapor channels have sintered powdered metal fused about the peripheries to form a porous capillary wick structure. A substantial number of liquid arteries extend transversely through the wicks adjacent the respective upper and lower surfaces of the housing, the arteries extending through the wall of the housing between the vapor channels and the main liquid channel and open into the main liquid channel. Liquid from the main channel enters the artery at the heat input end, wets the wick and is vaporized. When the vapor is cooled at the heat output end, the condensed vapor refills the wick and the liquid reenters the main liquid channel. NASA

**N87-29770#** Royal Aircraft Establishment, Farnborough (England).

**ON CRITERIA FOR SEPARATION IN TWO-DIMENSIONAL STEADY AND UNSTEADY COMPRESSIBLE FLOW**

F. Zhang and H. Forsching Dec. 1986 32 p Transl. into ENGLISH from Ueber Ablaesekriterien fuer Zweidimensionale Stationaere und Instationaere Kompressible Stroemungen (West Germany)

(RAE-Trans-2158; DFVLR-FB-85-60) Copyright Avail: NTIS HC A03/MF A01

A brief review of the most important flow separation phenomena is presented and the governing physical influencing parameters are outlined. Then, based on the theory of viscous flow, reference is made to Prandtl's boundary-layer concept as a basis for further considerations, and the most important flow separation criteria at present known are discussed. Finally, from a study of the streamline behavior near a separation point, generalized criteria are derived for separation in two dimensional steady and unsteady compressible flow. Author

**N87-29771#** Argonne National Lab., Ill. Materials and Components Technology Div.

**LEAKAGE FLOW-INDUCED VIBRATION OF AN UNCONSTRICTED TUBE-IN-TUBE SLIP JOINT**

T. M. Mulcahy Dec. 1986 22 p Presented at the Vibration Conference, Boston, Mass., 27-30 Sep. 1986

(Contract W-31109-eng-38)

(DE87-004844; CONF-8609233-1) Avail: NTIS HC A02/MF A01

The conditions are given for which the more flexible of two cantilevered, telescoping tubes conveying fluid can be self-excited by flow leaking from an unconstricted slip joint. Also, a physical explanation of the excitation mechanism is discussed, and a design rule to avoid the mechanism is presented. In addition, the results for the unconstricted slip joint are shown to be similar to those for slip joints having annulus constrictions at very short engagement lengths. DOE

**N87-29772#** Sandia National Labs., Albuquerque, N. Mex.

**CTH: A THREE-DIMENSIONAL, LARGE DEFORMATION, SHOCK WAVE PHYSICS CODE**

J. M. McGlaun, F. J. Zeigler, and S. L. Thompson 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987

(Contract DE-AC04-76DP-00789)

(DE87-011315; SAND-87-0726C; CONF-870753-10) Avail: NTIS HC A02/MF A01

CTH is a code system under development at Sandia National Laboratories to model multidimensional, multi-material, large deformation, strong shock physics. One-dimensional, two-dimensional and three-dimensional Eulerian capabilities have been implemented first. Highly accurate analytic and tabular equations of state with solid, liquid, vapor, gas-liquid mixed phase and solid-liquid mixed phase capabilities can be used. The architecture of CTH was designed to accommodate other numcerical approaches such as Lagrangian or ALE methods. CTH was carefully structured to run fast on a CRAY XMP. It is highly vectorized and multitasked. We briefly discuss the models used in CTH, techniques used to multitask the code and example calculation. DOE

**N87-29773#** Los Alamos National Lab., N. Mex.

**BIRCH'S LAW FOR FLUID METALS**

J. W. Shaner, R. S. Hixson, M. A. Winkler, D. A. Boness, and J. M. Brown 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987 Prepared in cooperation with Washington Univ., Seattle.

(Contract W-7405-eng-36)

(DE87-011729; LA-UR-87-2233; CONF-870753-7) Avail: NTIS HC A02

By comparing acoustic velocities in fluid metals over a very wide range of densities we have established Birch's Law as an approximate representation over the entire liquid range. For a given liquid metal the acoustic velocity is close to linear in density, with a slope determined by the atomic weight. The measurements include isobaric expansion to less than half normal density, ultrasonics on molten metals at 1 atmosphere, and shock melted metals to greater than twice normal density. DOE

**N87-29774#** Los Alamos National Lab., N. Mex.

**TRANSIENT DIRECT-CONTACT CONDENSATION ON LIQUID DROPLETS**

K. O. Pasamehmetoglu and R. A. Nelson 1987 24 p Presented at the 24th National Heat Transfer Conference and Exhibition, Pittsburgh, Pa., 9 Aug. 1987

(Contract W-7405-eng-36)

(DE87-005108; LA-UR-87-118; CONF-870816-2) Avail: NTIS HC A02/MF A01

In this paper, direct-contact condensation on subcooled liquid droplets is studied in two parts. In the first part, simple design correlations for the condensation in a steady environment are developed based upon a conduction model. These correlations include the convective heat-transfer coefficient, condensation rate, total condensation, and the droplet-thermalization time. In the second part of the paper, the effect of a time-dependent saturation temperature on the condensation process is investigated. A rapid decrease in saturation temperature is typical of condensation environments in which the steam-supply rate is limited and condensation-induced depressurization becomes important. Design correlations are developed for condensation in an environment in which the saturation temperature decreases linearly with time. These correlations are graphically compared to the design correlations of the first part through a quasi-steady approach. The error associated with this approach is quantified as a function of the rate of change of the saturation temperature. DOE

**N87-29775#** Westinghouse Research and Development Center, Pittsburgh, Pa.

**EFFECTS OF FIN PATTERN ON THE AIR SIDE HEAT TRANSFER COEFFICIENT IN PLATE FINNED TUBE HEAT EXCHANGERS**

D. T. Beecher and T. J. Fagan Jun. 1987 29 p Presented at the American Society of Heating, Refrigerating and Air-Conditioning Engineers Meeting, Nashville, Tenn., 28 Jun. 1987

(Contract DE-AC05-84OR-21400)

(DE87-010908; CONF-870620-6) Avail: NTIS HC A03/MF A01

The effects of air velocity, heat exchanger geometry and fin pattern on air side heat transfer in plate finned tube heat exchangers were investigated experimentally using a single fin passage model. The geometric parameters considered included tube diameter, transverse tube spacing, longitudinal tube spacing, number of tube rows and fin spacing. The effects of fin pattern depth and number of fin patterns per longitudinal tube row were investigated for a pattern consisting of corrugations of triangular cross section transverse to the direction of air flow. The heat transfer data were correlated in terms of the dimensionless heat transfer coefficient (Nussult number) based on the arithmetic mean

temperature difference Nu/sub a/ and the Graetz number Gz, a dimensionless measure of the level of flow development. DOE

**N87-29776#** Argonne National Lab., Ill.
**TWO-FLUID MODEL FOR TWO-PHASE FLOW**
M. Ishii 1987 65 p Presented at the Department of Energy International Workshop on Two-phase Flow Fundamentals, Troy, N.Y., 16 Mar. 1987
(Contract W-31-109-eng-38)
(DE87-011498; CONF-870320-3) Avail: NTIS HC A04/MF A01

The two-fluid model formulation is discussed in detail. The emphasis of the paper is on the three-dimensional formulation and the closure issues. The origin of the interfacial and turbulent transfer terms in the averaged formulation is explained and their original mathematical forms are examined. The interfacial transfer of mass, momentum, and energy is proportional to the interfacial area and driving force. This is not a postulate but a result of the careful examination of the mathematical form of the exact interfacial terms. These two effects are considered separately. Since all the interfacial transfer terms involve the interfacial area concentration, the accurate modeling of the local interfacial area concentration is the first step to be taken for a development of a reliable two-fluid model closure relations. The interfacial momentum interaction has been studied in terms of the standard-drag, lift, virtual mass, and Basset forces. Available analytical and semi-empirical correlations and closure relations are reviewed and existing shortcomings are pointed out. The other major area of importance is the modeling of turbulent transfer in two-phase flow. The two-phase flow turbulence problem is coupled with the phase separation problem even in a steady-state fully developed flow. Thus the two-phase turbulence cannot be understood without understanding the interfacial drag and lift forces accurately. There are some indications that the mixing length type model may not be sufficient to describe the three-dimensional turbulent and flow structures. Although it is a very difficult challenge, the two-phase flow turbulence should be investigated both experimentally and analytically with long time-scale research. DOE

**N87-29777#** Lawrence Livermore National Lab., Calif.
**A BRIEF REVIEW ON CAVITATION BUBBLE COLLAPSE NEAR A SOLID BOUNDARY**
D. J. Steinberg Jun. 1987 13 p
(Contract W-7405-eng-48)
(DE87-013116; UCID-21054) Avail: NTIS HC A02/MF A01

A brief review of cavitation bubble collapse near a solid boundary includes a comprehensive bibliography with 67 citations of work published since 1960. The 67 references presented here deal almost solely with cavitation bubble collapse in the vicinity of a rigid wall or boundary. DOE

**N87-29778*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**DESCRIPTION AND CALIBRATION OF THE LANGLEY HYPERSONIC CF4 TUNNEL: A FACILITY FOR SIMULATING LOW GAMMA FLOW AS OCCURS FOR A REAL GAS**
Raymond E. Midden and Charles G. Miller, III Mar. 1985 78 p
(NASA-TP-2384; L-15798; NAS 1.60:2384) Avail: NTIS HC A05/MF A01 CSCL 20D

The Langley Hypersonic CF4 Tunnel is a Mach 6 facility which simulates an important aspect of dissociative real-gas phenomena associated with the reentry of blunt vehicles, i.e., the decrease in the ratio of specific heats (gamma) that occurs within the shock layer of the vehicle. A general description of this facility is presented along with a discussion of the basic components, instrumentation, and operating procedure. Pitot-pressure surveys were made at the nozzle exit and downstream of the exit for reservoir temperatures from 1020 to 1495 R and reservoir pressures from 1000 to 2550 psia. A uniform test core having a diameter of circa 11 in. (0.55 times the nozzle-exit diameter) exists at the maximum value of reservoir pressure and temperature. The corresponding free-stream Mach number is 5.9, the unit Reynolds number is 4 x 10 to the 5th power per foot, the ratio of specific heats immediately behind a normal shock is 1.10, and the normal-shock density ratio is 12.6. When the facility is operated at reservoir temperatures below 1440 R, irregularities occur in the pitot-pressure profile within a small region about the nozzle centerline. These variations in pitot pressure indicate the existence of flow distrubances originating in the upstream region of the nozzle. This necessitates testing models off centerline in the uniform flow between the centerline region and either the nozzle boundary layer or the lip shock originating at the nozzle exit. Samples of data obtained in this facility with various models are presented to illustrate the effect of gamma on flow conditions about the model and the importance of knowing the magnitude of this effect. Author

**N87-29779#** Stuttgart Univ. (West Germany). Inst. fuer Computer - Anwendungen.
**EFFECTIVE NUMERICAL METHOD FOR THE TREATMENT OF INCOMPRESSIBLE VISCOUS FLOW PHENOMENA Ph.D. Thesis [EFFEKTIVE NUMERISCHE VERFAHREN ZUR BEHANDLUNG INKOMPRESSIBLER VISKOSER STROEMUNGSVORGAENGE]**
Hans Wuestenberg 1986 106 p In GERMAN
(ETN-87-90037) Avail: NTIS HC A06/MF A01

Finite element methods for incompressible viscous flow phenomena were investigated. Thermally coupled phenomena are included. The discretization of the basic equations, and time integration methods are presented. Schemes for the effective solution of the resulting large linear equation systems were developed. Under certain assumptions iterative methods are superior to direct methods. The application domain of the different solution methods is determined by simple examples. The design of a programming system for the development and application of the described method is outlined. The advantages of the concept are demonstrated by the simultaneous treatment of several coupled field problems. ESA

**N87-29780#** Kernforschungsanlage, Juelich (West Germany). Inst. fuer Reaktorbauelemente.
**CALCULATION OF THE HEAT TRANSFER IN THE REGION OF SEPARATED FLOW DOWNSTREAM OF A SUDDEN CROSS SECTION EXPANSION**
E. Achenbach and D. Froning Dec. 1986 58 p In GERMAN; ENGLISH summary
(JUEL-2106; ISSN-0366-0885; ETN-87-90345) Avail: NTIS HC A04/MF A01

The forced convective heat transfer in a two-dimensional channel with a sudden expansion at one side was calculated. The vorticity equation and the energy equation were solved by the Crank-Nicholson procedure. The influence of the Reynolds number (between 10 and 2000) and the Prandtl number (between 0.7 and 2.5) on the flow and the heat transfer were considered. With increasing Reynolds number, the length of the recirculation zone grows, reaching 11 to 12 step heights above 1000. The effect of the Prandtl number on the heat transfer can be approximated by the function Pr to the power 1/3. The theoretical results agree well with experimental data. The two methods applied to solve the equations of motion show that the implicit procedure is more appropriate at high Reynolds numbers, but requires 25% more computing time. ESA

**N87-29781#** Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Neutronenphysik und Reaktortechnik.
**VELOCITY AND TURBULENCE DISTRIBUTIONS IN WALL SUBCHANNELS OF A ROAD BUNDLE IN THREE AXIAL PLANES DOWNSTREAM OF A SPACER GRID**
K. Rehme Mar. 1987 76 p In GERMAN; ENGLISH summary
(KfK-4199; ISSN-0303-4003; ETN-87-90351) Copyright Avail: NTIS HC A05/MF A01

The velocity, turbulence, and temperature distributions in nuclear fuel element bundles of nuclear reactors were investigated. The mean velocity, the wall shear stresses, and the turbulence were measured in two wall subchannels of a rod bundle of four parallel rods, arranged in a rectangular channel, for three axial planes. A spacer grid was inserted in the rod bundle, for ratios between the distance spacer grid/measuring plane and the hydraulic diameter (LIDh) of 40.4, 32.8 and 16.9. The Reynolds number was 145,000.

The results show that the distributions of the velocity and the turbulence are affected by the spacer grid, already for LIDh = 40.4. The effects of the spacer grid increase with decreasing distance to the spacer grid. ESA

**N87-29782#** Naval Ship Research and Development Center, Bethesda, Md. Ship Performance Dept.
**ANALYTICAL APPROXIMATION FOR STEADY SHIP WAVES AT LOW FROUDE NUMBERS Final Report**
Francis Noblesse Sep. 1986 17 p
(DTNSRDC-86/058) Avail: NTIS HC A02/MF A01 CSCL 20D

A simple analytical relationship between a ship hull form and its steady far field Kelvin wake is obtained by considering the low-Froude-number limit of the Newmann-Kelvin theory. In particular, this relationship predicts the occurrence of a sharp peak in the amplitude of the waves in the far field Kelvin wake at an angle, alpha, from the ship track that is smaller than the Kelvin-cusp angle of 19 degrees 1/2 for a hull form which has a small region of flare and is wall sided everywhere else, if the Froude number is sufficiently small. An explicit relationship between the angle, phi, between the ship track and the tangent to the ship mean waterline in the region of the flare and the corresponding wave-peak angle alpha in the Kelvin wake is obtained. For instance, this relationship predicts the occurrence of a sharp peak in wave amplitude at an angle alpha in the Kelvin wake equal to 14 degrees for a hull having a small region of flare within which the waterline-tangent angle phi is approximately equal to either 30 or 74 degrees. This theoretical result may explain the bright returns that were sometimes observed in SAR images of ship wakes at angles smaller than the Kelvin-cusp angle. The low-Froude-number asymptotic analysis of the Neumann-Kelvin theory presented also predicts that the wave-resistance coefficient is 0(F sup 2), where F is the Froude number, for a ship form with a region of flare, 0(F sup 4) for a ship form that is wall sided everywhere and has either a bow or a stern (or both) that is neither cusped nor round, and 0(F sup 6) for a wall sided ship form with both bow and stern that are either cusped or round. Author

**N87-29783#** Naval Ship Research and Development Center, Bethesda, Md. Ship Performance Dept.
**FAR-FIELD FEATURES OF THE KELVIN WAKE Final Report**
A. Barnell and F. Noblesse Sep. 1986 26 p
(DTNSRDC-86/054) Avail: NTIS HC A03/MF A01 CSCL 20D

The classical Kelvin wake trailing a ship advancing at constant speed in calm water is studied. In particular, asymptotic expressions for determining the far-field wake, at large distances behind the ship, are investigated numerically. This analysis, in which surface tension and nonlinearities are ignored, indicates that the divergent waves of a surface ship generally are infinitely steep at the track of the ship, even though their amplitude vanishes there; this result is theoretically possible because the wavelength of the divergent waves vanishes at the track of the ship. Inasmuch as infinitely-steep water waves cannot exist in reality, the linear no-surface-tension analysis presented suggests that no divergent waves can exist within a certain region in the vicinity of the track of the ship, and that the Kelvin wake contains three distinct regions: an inner region where only transverse waves can exist, an outer region where both transverse and divergent waves are present, and an intermediate region at the boundary between the inner and outer regions where short steep divergent waves, as well as transverse waves, can be found. These results appear to be consistent with the narrow-V wakes observed in some SAR images of ship wakes. The analysis may thus provide a partial explanation for these observations. Author

**N87-29784*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**BOUNDARY-LAYER EQUATIONS IN GENERALIZED CURVILINEAR COORDINATES**
Argyris G. Panaras Aug. 1987 35 p
(NASA-TM-100003; A-87272; NAS 1.15:100003) Avail: NTIS HC A03/MF A01 CSCL 20D

A set of higher-order boundary-layer equations is derived valid for three-dimensional compressible flows. The equations are written in a generalized curvilinear coordinate system, in which the surface coordinates are nonorthogonal; the third axis is restricted to be normal to the surface. Also, higher-order viscous terms which are retained depend on the surface curvature of the body. Thus, the equations are suitable for the calculation of the boundary layer about arbitrary vehicles. As a starting point, the Navier-Stokes equations are derived in a tensorian notation. Then by means of an order-of-magnitude analysis, the boundary-layer equations are developed. To provide an interface between the analytical partial differentiation notation and the compact tensor notation, a brief review of the most essential theorems of the tensor analysis related to the equations of the fluid dynamics is given. Many useful quantities, such as the contravariant and the covariant metrics and the physical velocity components, are written in both notations. Author

**N87-29785*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**DISCONTINUOUS SOLUTIONS TO HYPERBOLIC SYSTEMS UNDER OPERATOR SPLITTING Final Report**
P. L. Roe (Cranfield Inst. of Tech., Bedford, England ) Sep. 1987 35 p Submitted for publication
(Contract NAS1-18107)
(NASA-CR-178375; ICASE-87-64; NAS 1.26:178375) Avail: NTIS HC A03/MF A01 CSCL 20D

Two-dimensional systems of linear hyperbolic equations are studied with regard to their behavior under a solution strategy that in alternate time-steps solves exactly the component one-dimensional operators. The initial data is a step function across an oblique discontinuity. The manner in which this discontinuity breaks up under repeated applications of the split operator is analyzed, and it is shown that the split solution will fail to match the true solution in any case where the two operators do not share all their eigenvectors. The special case of the fluid flow equations is analyzed in more detail, and it is shown that arbitrary initial data gives rise to pseudo acoustic waves and a non-physical stationary wave. The implications of these findings for the design of high-resolution computing schemes are discussed. Author

**N87-29786*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**SPECTRAL COLLOCATION METHODS Final Report**
M. Y. Hussaini, D. A. Kopriva, and A. T. Patera (Massachusetts Inst. of Tech., Cambridge.) Sep. 1987 71 p Submitted for publication
(Contract NAS1-18107)
(NASA-CR-178373; ICASE-87-62; NAS 1.26:178373) Avail: NTIS HC A04/MF A01 CSCL 20D

This review covers the theory and application of spectral collocation methods. Section 1 describes the fundamentals, and summarizes results pertaining to spectral approximations of functions. Some stability and convergence results are presented for simple elliptic, parabolic, and hyperbolic equations. Applications of these methods to fluid dynamics problems are discussed in Section 2. Author

**N87-29787#** Mississippi State Univ., Mississippi State. Dept. of Mechanical and Nuclear Engineering.
**AN EXPERIMENTAL STUDY OF SURFACE ROUGHNESS EFFECTS ON TURBULENT BOUNDARY LAYER FLOW AND HEAT TRANSFER Annual Technical Report, 15 May 1986 - 14 May 1987**
Hugh W. Coleman and Robert P. Taylor Jun. 1987 46 p
(Grant AF-AFOSR-0178-86)
(AD-A182913; AFOSR-87-0895TR) Avail: NTIS HC A03/MF A01 CSCL 20D

During the first year of this program the calibration and qualification of the turbulent heat transfer test apparatus were completed for heat transfer measurements. The heat transfer data

taken for zero pressure gradient, constant wall temperature, incompressible flow over a smooth wall agree with standard, accepted data sets for such conditions within the scatter of the standard data. GRA

**N87-29788#** Michigan Univ., Ann Arbor. Dept. of Mathematics.
**COMPUTATIONAL AND EXPERIMENTAL FLUID DYNAMICS Final Report, 1 Jun. 1984 - 30 Sep. 1985**
L. R. Scott 19 Aug. 1986 14 p
(Contract N00014-84-K-0499)
(AD-A183230) Avail: NTIS HC A02/MF A01 CSCL 20D

Research on both internal and free-surface flows related to experimental situations was continued. Part of this research was based on using a low-order code developed previously, jointly by Pritchard and Scott. Funds for the programmer allowed two substantial new programming projects to be initiated during this time. One concerned investigation of techniques for implementing a quartic finite element method for viscous, incompressible, two-dimensional flows. The other involved a streamline-diffusion finite element method for inviscid flows. GRA

**N87-29789#** Naval Research Lab., Washington, D.C.
**A PRESSURE GRADIENT ALGORITHM TO MAINTAIN A STATISTICALLY STEADY STATE TURBULENT CHANNEL FLOW**
Leonidas Sakell and R. J. Hansen 27 Jul. 1987 15 p
(AD-A183292; NRL-MR-6017) Avail: NTIS HC A02/MF A01 CSCL 20D

An algorithm is presented for the computation of streamwise pressure gradient for use in the computation of turbulent channel flow using the full incompressible Navier-Stokes equations of motion. The algorithm is fully hands off. No assumptions or constants are employed. Forces balance exactly throughout the calculations. Results are presented which show that a statistically steady turbulent state is reached and maintained using this algorithm. GRA

**N87-29790#** Naval Postgraduate School, Monterey, Calif.
**A FLOW VISUALIZATION STUDY OF LAMINAR/TURBULENT TRANSITION IN A CURVED CHANNEL M.S. Thesis**
Marc A. Siedband Mar. 1987 126 p
(AD-A183359) Avail: NTIS HC A07/MF A01 CSCL 20D

Laminar/turbulent transition was studied as it occurs in a newly constructed curved channel of rectangular cross section. The channel is 1.27 centimeters high by 50.8 centimeters wide (0.5 in. x 20 in.), aspect ratio of 40 to 1, with a concave surface radius of curvature of 60.96 centimeters (24 in.). Mean velocities for air in the channel range from 1.40 to 3.89 m/sec, correspond to Dean number and hydraulic Reynolds number ranges of 167 to 4651 and 2,231 to 6,173, respectively. Flow visualization from a smoke ire shows changes in the behavior and appearance of a smoke trace illuminated in the radial plane with varying Dean number and varying channel location. In some cases, these smoke trace patterns show distortion similar to what would be expected if pairs of counter-rotating vortices are present. A map of vortex stability was constructed from analysis of smoke trace photographs as channel location and Dean number were varied. GRA

**N87-29791#** Naval Postgraduate School, Monterey, Calif.
**STUDY OF VORTICES EMBEDDED IN BOUNDARY LAYERS WITH FILM COOLING M.S. Thesis**
David L. Evans Mar. 1987 101 p
(Contract MIPR-FY-1455-86-N0616)
(AD-A183428) Avail: NTIS HC A06/MF A01 CSCL 20D

Measurements are presented of boundary layers with embedded vortices and with filmcooling for freestream velocities of 15, and 11 m/s. Measurements of a boundary layer with embedded vortex and no film cooling, and of a boundary layer with film cooling but no vortex are presented for freestream velocity of 15 m/s. Plots of total velocity, V, streamwise velocity, V sub x, secondary flow vectors, total pressure, P sub o, and streamwise vorticity are presented for many of these test conditions. The results show that the embedded vortices completely dominate the flow field in boundary layers with film cooling. This is indicated from the plots of V, V sub x, and P sub o which show the effects of film cooling to be completely decimated in the vicinity of the vortex. In order to conduct this study, a five hole pressure probe was calibrated for pitch and yaw. The probe was then used to measure five pressures associated with the flow. From these pressures, total velocity and the x, y, and z components of velocity were determined. A boundary layer profile was conducted to verify the calibration of the pressure probe, measurement procedures, and velocity computations. The results show expected boundary layer behavior with a small V sub y and V sub z component. GRA

**N87-29792#** Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
**MODELING AND MEASUREMENT OF TURBULENT SWIRLING FLOWS THROUGH ABRUPT EXPANSIONS Final Report**
G. P. Neitzel and D. E. Metzger Mar. 1987 114 p
(Contract N00014-81-K-0428)
(AD-A183674; ASU-TR-ERC-R-86104) Avail: NTIS HC A06/MF A01 CSCL 20D

This report on turbulent swirling flows contains the following: A study of sudden expansion pipe flow using an algebraic-stress model of turbulence; Comment on The flowfield in a suddenly enlarged combustion chamber; Turbulent flow prediction in a sudden axisymmetric expansion; Heat transfer to turbulent swirling flow through a sudden axisymmetric expansion; Measurements in turbulent swirling flow through an abrupt axisymmetric expansion. The first three papers describe numerical predictions of the flowfield. The next describes experimental measurements of local convective heat transfer on the tube walls downstream of expansion. The last describes detailed mean and fluctuating flowfield measurements both upstream and downstream of the expansion including precessing vortex core phenomena. GRA

**N87-29793#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**MOTION FIELD AND OPTICAL FLOW: QUALITATIVE PROPERTIES**
Alessandro Verri and Tomaso Poggio Dec. 1986 34 p Sponsored in part by Hughes Aircraft Co.
(Contract N00014-85-K-0214)
(AD-A183727; AI-M-917) Avail: NTIS HC A03/MF A01 CSCL 12I

The optical flow, a 2-D field that can be associated with the variation of the image brightness pattern, and the 2-D motion field, the projection on the image plane of the 3-D velocity field of a moving scene, are in general different, unless very special conditions are satisfied. The optical flow, therefore, is ill suited for computing structure from motion, and for reconstructing the 3-D velocity field, problems that require an accurate estimate of the 2-D motion field. A different use of the optical flow is suggested. Stable field and the 3-D structure of the scene, and they can usually be obtained from the optical flow. The smoothed optical flow and 2-D motion field, interpreted as vector fields tangent to flows of planar dynamical systems, may have the same qualitative properties from the point of view of the theory of structural stability of dynamical systems. GRA

**N87-29794*#** Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
**INTERACTION OF TRANSIENT RADIATION IN NONGRAY GASEOUS SYSTEMS Progress Report, period ending 31 Dec. 1986**
S. N. Tiwari and D. J. Singh Jan. 1987 112 p
(Grant NAG1-423)
(NASA-CR-181389; NAS 1.26:181389) Avail: NTIS HC A06/MF A01 CSCL 20D

A general formulation is presented to investigate the transient radiative interaction in nongray absorbing-emitting species between two parallel plates. Depending on the desired sophistication and accuracy, any nongray absorption model from line-by-line models to the wide band model correlations can be employed in the

formulation to investigate the radiative interaction. Special attention is directed to investigate the radiative interaction in a system initially at a uniform reference temperature and suddenly the temperature of the bottom plate is reduced to a lower but constant temperature. The interaction is considered for the case of radiative equilibrium as well as for combined radiation and conduction. General as well as limiting forms of the governing equations are presented and solutions are obtained numerically by employing the method of variation of parameters. Specific results are obtained for CO, CO2, H2O, and OH. The information on species H2O and OH is of special interest for the proposed scramjet engine application. The results demonstrate the relative ability of different species for radiative interactions. Author

**N87-29795*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**FINITE-ELEMENT REENTRY HEAT-TRANSFER ANALYSIS OF SPACE SHUTTLE ORBITER**
William L. Ko, Robert D. Quinn, and Leslie Gong Dec. 1986 59 p
(NASA-TP-2657; H-1236; NAS 1.60:2657) Avail: NTIS HC A04/MF A01 CSCL 20D

A structural performance and resizing (SPAR) finite-element thermal analysis computer program was used in the heat-transfer analysis of the space shuttle orbiter subjected to reentry aerodynamic heating. Three wing cross sections and one midfuselage cross section were selected for the thermal analysis. The predicted thermal protection system temperatures were found to agree well with flight-measured temperatures. The calculated aluminum structural temperatures also agreed reasonably well with the flight data from reentry to touchdown. The effects of internal radiation and of internal convection were found to be significant. The SPAR finite-element solutions agreed reasonably well with those obtained from the conventional finite-difference method. Author

**N87-29796** California Univ., Los Angeles.
**THREE-DIMENSIONAL RAYLEIGH-TAYLOR INSTABILITY: EXPERIMENT AND THEORY Ph.D. Thesis**
Jeffrey Warren Jacobs 1986 189 p
Avail: Univ. Microfilms Order No. DA8712343

Three-dimensional weakly nonlinear, Rayleigh-Taylor instability is analyzed. The stability of a confined inviscid liquid and an overlying gas with density much less than that of the liquid is considered. An asymptotic solution for containers of arbitrary cross-sectional geometry, valid up to order epsilon sup 3 is obtained. The solution is evaluated for the rectangular and circular geometries and for various initial modes. It is found that the hexagonal and axisymmetric instabilities grow faster than any other shapes in their respective geometries. The Rayleigh-Taylor instability of air/water is investigated experimentally in a fully three-dimensional configuration. Two geometries are investigated: a 6.25 inch circular tube and a 5 inch square tube were used. The resulting instability was recorded and later analyzed with the aid of high speed motion picture photography. In the runs without forced initial conditions, instabilities of axisymmetric planform in the circular geometry and square planform in the square geometry were observed. In the runs with forced initial conditions, measurements of the growth rate are found to agree well with linear theory. In addition, good qualitative agreement between photographs and 3-D surface plots of the weakly nonlinear solution is obtained. Dissert. Abstr.

**N87-29797** Michigan State Univ., East Lansing.
**LAMINAR FLOW SEPARATION IN A CONSTRICTED CHANNEL Ph.D. Thesis**
Najdat Nashat Abdulla 1987 180 p
Avail: Univ. Microfilms Order No. DA8714291

The two-dimensional, incompressible, laminar flow in the entrance region of a channel with and without constrictions was analyzed numerically for various step-to-channel height ratios, step lengths and step positions for Reynolds numbers up to 2000, based on the channel height. A stream function-vorticity formulation is used in conjunction with a finite-difference, over-relaxation method utilizing accelerating parameters to solve the full Navier-Stokes equations which describe steady flow. The power of the method is contained in the structure of the finite-difference equations, which, for all Reynolds numbers, yields a diagonally dominant system of linear, algebraic equations. This avoids the numerical instability of the finite difference equations at high Reynolds numbers. The stream function, vorticity, streamwise velocity and pressure are reported at each grid point. The inviscid-core region and profile-development region, which form the entrance length, are identified for various Reynolds numbers and inlet velocity profiles. The centerline velocity and entrance length for the channel without a constriction are compared with the results obtained by approximate techniques. Also, the separation and reattachment points for a constricted channel are compared with both numerical and experimental results. Dissert. Abstr.

**N87-29798** Drexel Univ., Philadelphia, Pa.
**FLOW FIELD AND HEAT TRANSFER ASSOCIATED WITH A FORWARD FACING STEP Ph.D. Thesis**
Amichai Baron 1987 239 p
Avail: Univ. Microfilms Order No. DA8712924

Numerical studies of the flow field and heat transfer associated with a forward facing step are carried out. A two dimensional incompressible flow is considered and the fluid is of constant properties. Both laminar and turbulent flows are studied. In addition, measurements of the heat transfer over the leading and top plates are conducted in a Ludwieg tube. The power-law numerical scheme, combined with a false transient technique, is applied in a vorticity stream-function approach. In order to overcome numerical difficulties due to the steep gradient of vorticity at the wall, an approach to the wall vorticity boundary condition is introduced. The flow field may have one or two recirculating regions, depending upon the boundary layer thickness of the approaching flow. The size of the recirculating regions in laminar flow depends on the Reynolds number of the flow. Special attention is given to the configuration of the blunt plate as a particular case of a forward facing step with no leading plate. Results of the computational phase are in reasonable to good agreement with the available experimental data. Computed rates of heat transfer are in good agreement with measured data far downstream of the step. Measured data in the neighborhood of the step suggest dependency of the size of the recirculating region on the Reynolds. Such a trend is not a characteristic of recirculating regions in turbulent flows and is not detected by the present computations. Dissert. Abstr.

**N87-29454*#** Spectron Development Labs., Inc., Costa Mesa, Calif.
**KC-135 AERO-OPTICAL TURBULENT BOUNDARY LAYER/ SHEAR LAYER EXPERIMENT REVISITED**
J. Craig and C. Allen (Air Force Weapons Lab., Kirtland AFB, N. Mex.) *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 461-503 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 20D

**N87-29455*#** Lockheed-Georgia Co., Marietta.
**AUTOMATED REDUCTION OF INSTANTANEOUS FLOW FIELD IMAGES**
G. A. Reynolds, M. Short, and M. C. Whiffen *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 505-524 Previously announced in IAA as A85-35206 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 20D

**N87-29456*#** Gunma Univ., Maebashi (Japan). Dept. of Mechanical Engineering.
**IMAGE ANALYSIS OF PARTICLE FIELD BY MEANS OF COMPUTED TOMOGRAPHY**
Mitsushige Nakayama *In* NASA. Ames Research Center,

Automated Reduction of Data from Images and Holograms May 1987 p 525-539 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 20D

**N87-29460*#** General Motors Research Labs., Warren, Mich. Instrumentation Dept.
**IMAGE PROCESSING SYSTEM TO ANALYZE DROPLET DISTRIBUTIONS IN SPRAYS**
Gary P. Bertollini, Larry M. Oberdier, and Yong H. Lee *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 607-640 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 20D

**N87-30147#** Joint Publications Research Service, Arlington, Va.
**NONISOTHERMAL INSTABILITY OF HIGH-VELOCITY FLOW OF ELASTOPLASTIC BODIES Abstract Only**
V. M. Volchkov, A. A. Kozlov, and P. V. Kuzin *In its* USSR Report: Physics and Mathematics 9 Apr. 1987 p 18 Transl. into ENGLISH from Zhurnal Prikladnoy Mekhaniki i Tekhnicheskoy Fiziki (Novosibirsk, USSR), no. 3, May - Jun. 1986 p 133-138 (For primary document see N87-30145 24-70)
Avail: NTIS HC A04/MF A01

# 35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing*. For related information see also *06 Aircraft Instrumentation*, and *19 Spacecraft Instrumentation*.

**N87-29799*#** National Aeronautics and Space Administration. Pasadena Office, Calif.
**THERMOCOUPLE FOR HEATING AND COOLING OF MEMORY METAL ACTUATORS Patent Application**
Charles Wood, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 23 Jul. 1987 15 p
(Contract NAS7-918)
(NASA-Case-NPO-17068-1-CU; NAS 1.71:NPO-17068-1-CU; US-Patent-Appl-SN-076956) Avail: NTIS HC A02/MF A01 CSCL 14B

A semiconductor thermocouple unit is provided for heating and cooling of memory metal actuators. The semiconductor thermocouple unit is mounted adjacent to a memory metal actuator and has a heat sink attached to it. A flexible thermally conductive element extends between the semiconductor thermocouple and the actuator and serves as a heat transfer medium during heating and cooling operations. NASA

**N87-29800*#** National Aeronautics and Space Administration, Washington, D.C.
**STIGMATICALLY FOCUSING PARTIAL PRESSURE ANALYZER WITH DUAL CHAMBER ION SOURCE Ph.D. Thesis - Technical Univ. of Munich, 1971**
Klaus F. Rasskopf Sep. 1987 47 p Transl. into ENGLISH of German Thesis p 1-43 Original language document was announced in IAA as A72-22318 Transl. by The Corporate Word, Inc., Pittsburgh, Pa.
(Contract NASw-4006)
(NASA-TT-20059; NAS 1.77:20059) Avail: NTIS HC A03/MF A01 CSCL 14B

The partial pressure analyzer developed has a high absolute sensitivity and high resolution. Interaction effects, as they occur in conventional partial pressure analyzers between the heating filament for the emission of electrons and the residual gas, are suppressed by removing the heating filament from the measurement area. The electron beam is generated in an auxiliary vacuum compartment, and passes subsequently through an aperture into the ionization compartment. The probability is small, therefore, that the presence of substances produced at the heating filament by chemical reactions and thermal decompositions will have disturbing effects. The high sensitivity and resolution of the instrument are obtained with the aid of an electron path configuration of unconventional characteristics. Author

**N87-29801#** Arnold Engineering Development Center, Arnold Air Force Station, Tenn.
**SECOND-GENERATION DISCRETE FOURIER TRANSFORM SIGNAL PROCESSOR FOR LASER VELOCIMETRY Final Report, 1 Dec. 1984 - 15 Aug. 1986**
Thomas Chris Layne and Bruce William Bomar Dec. 1986 39 p Prepared in cooperation with Calspan Field Services, Inc., Arnold AFS, Tenn. and Tennessee Univ. Space Inst., Tullahoma.
(AD-A176519; AEDC-TR-86-33) Avail: NTIS HC A03/MF A01 CSCL 14B

A high-speed, single-board digital processor has been developed at the AEDC for frequency domain analysis of laser velocimeter signals. The analysis is facilitated by the discrete Fourier transform (DFT), which is used to determine a signal's spectral content. The processor consists of a microprogrammable microprocessor controlling circuitry specially designed for fast, efficient computation of the DFT. The DFT computation circuitry, which features a dual multiplier/accumulator architecture, allows computation of one DFT coefficient per 11.3 microsecs for 113 data samples. The microprocessor searches for a dominant maximum in the frequency spectrum corresponding to the frequency of the input signal burst. Results from a laboratory evaluation of the processor are also included. Author

**N87-29802*#** Morgan State Univ., Baltimore, Md.
**THE CALIBRATION OF PHOTOGRAPHIC AND SPECTROSCOPIC FILMS. PART 1: FILM BATCH VARIATIONS OF RECIPROCITY FAILURE IN IIAO FILM. PART 2: THERMAL AND AGING EFFECTS IN RELATIONSHIP TO RECIPROCITY FAILURE. PART 3: SHIFTING OF RECIPROCITY FAILURE POINTS AS A FUNCTION OF THERMAL AND AGING EFFECTS Semiannual Report, 1 May - 30 Oct. 1987**
Kevin A. Peters, Pamela F. Atkinson, and Ernest C. Hammond, Jr Oct. 1987 51 p
(Grant NsG5-074)
(NASA-CR-181334; NAS 1.26:181334) Avail: NTIS HC A04/MF A01 CSCL 14E

Reciprocity failure was examined for IIaO spectroscopic film. Three separate experiments were performed in order to study film batch variations, thermal and aging effects in relationship to reciprocity failure, and shifting of reciprocity failure points as a function of thermal and aging effects. The failure was examined over ranges of time between 5 and 60 seconds. The variation to illuminance was obtained by using thirty neutral density filters. A standard sensitometer device imprinted the wedge pattern on the film as exposure time was subjected to variation. Results indicate that film batch differences, temperature, and aging play an important role in reciprocity failure of IIaO spectroscopic film. A shifting of the failure points was also observed in various batches of film. Author

**N87-29803*#** Morgan State Univ., Baltimore, Md.
**THE CALIBRATION OF PHOTOGRAPHIC AND SPECTROSCOPIC FILMS. A DENSITOMETRIC ANALYSIS OF IIAO FILM FLOWN ABOARD THE SPACE SHUTTLE TRANSPORTATION SYSTEM STS3, STS8, AND STS7 Semiannual Report, 1 May - 30 Oct. 1987**
Ernest C. Hammond, Jr. Oct. 1987 23 p
(Grant NsG5-074)
(NASA-CR-181333; NAS 1.26:181333) Avail: NTIS HC A02/MF A01 CSCL 14E

The results of these studies have implications for the utilization of the IIaO spectroscopic film on the future shuttle and space lab missions. These responses to standard photonic energy sources will have immediate application for the uneven responses of the film photographing a star field in a terrestrial or extraterrestrial environment with associated digital imaging equipment. B.G.

**N87-29804*#** Morgan State Univ., Baltimore, Md.
**THE CALIBRATION OF PHOTOGRAPHIC AND SPECTROSCOPIC FILMS. THE UTILIZATION OF THE DIGITAL IMAGE PROCESSOR IN THE DETERMINATION OF AGING OF THE SURF CLAM (SPISULA SOLIDISSIMA) SEMIANNUAL REPORT, 1 May - 30 Oct. 1987**
Kevin A. Peters and Ernest C. Hammond, Jr. Oct. 1987 8 p
(Grant NsG5-074)
(NASA-CR-181339; NAS 1.26:181339) Avail: NTIS HC A02/MF A01 CSCL 14E

The age of the surf clam (Spisula solidissima) can be determined with the use of the Digital Image Processor. This technique is used in conjunction with a modified method for aging, refined by John Ropes of the Woods Hole Laboratory, Massachusetts. This method utilizes a thinned sectioned chondrophore of the surf clam which contains annual rings. The rings of the chondrophore are then counted to determine age. By digitizing the chondrophore, the Digital Image Processor is clearly able to separate these annual rings more accurately. This technique produces an easier and more efficient way to count annual rings to determine the age of the surf clam. Author

**N87-29805*#** Technical Measurements, Inc., LaCanada, Calif.
**A CAVITY RADIOMETER FOR EARTH ALBEDO MEASUREMENT, PHASE 1 Final Report**
18 Oct. 1987 34 p
(Contract NAS5-30059)
(NASA-CR-181385; NAS 1.26:181385) Avail: NTIS HC A03/MF A01 CSCL 14B

Radiometric measurements of the directional albedo of the Earth requires a detector with a flat response from 0.2 to 50 microns, a response time of about 2 seconds, a sensitivity of the order of 0.02 mw/sq cm, and a measurement uncertainty of less than 5 percent. Absolute cavity radiometers easily meet the spectral response and accuracy requirements for Earth albedo measurements, but the radiometers available today lack the necessary sensitivity and response time. The specific innovations addressed were the development of a very low thermal mass cavity and printed/deposited thermocouple sensing elements which were incorporated into the radiometer design to produce a sensitive, fast response, absolute radiometer. The cavity is applicable to the measurement of the reflected and radiated fluxes from the Earth surface and lower atmosphere from low Earth orbit satellites. The effort consisted of requirements and thermal analysis; design, construction, and test of prototype elements of the black cavity and sensor elements to show proof-of-concept. The results obtained indicate that a black body cavity sensor that has inherently a flat response from 0.2 to 50 microns can be produced which has a sensitivity of at least 0.02 mw/sq cm per micro volt ouput and with a time constant of less than two seconds. Additional work is required to develop the required thermopile. Author

**N87-29433*#** Michigan Univ., Ann Arbor.
**INFORMATION RETRIEVAL FROM HOLOGRAPHIC INTERFEROGRAMS: FUNDAMENTALS AND PROBLEMS**
Charles M. Vest *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 1-20 Sponsored by the Army Research Office (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29434*#** Army Research and Technology Labs., Moffett Field, Calif.
**TRANSONIC ROTOR FLOW-MEASUREMENT TECHNIQUE USING HOLOGRAPHIC INTERFEROMETRY**
John K. Kittleson and Yung H. Yu *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 49-51 Previously announced in IAA as A86-17069 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29435*#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
**HOLOGRAPHIC INTERFEROMETRY AT WRIGHT AERONAUTICAL LABORATORIES Abstract Only**
Mel Roquemore *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 67 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 01A

**N87-29436*#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
**STATUS OF HOLOGRAPHIC INTERFEROMETRY AT WRIGHT PATTERSON AIR FORCE BASE Abstract Only**
George Seibert *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 69 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29437*#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.
**WELDING ARC AND PLASMA STUDIES USING REAL TIME, MULTIPASS HOLOGRAPHIC INTERFEROMETRY**
Vance Deason *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 71-76 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29438*#** Spectron Development Labs., Inc., Costa Mesa, Calif.
**HOLOGRAPHIC, PARTICLE IMAGING AND DATA REDUCTION AT SPECTRON DEVELOPMENT LABORATORES Abstract Only**
James D. Trolinger *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 77 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29439*#** Michigan Univ., Ann Arbor.
**STATUS OF HOLOGRAPHIC INTERFEROMETRY AT UNIVERSITY OF MICHIGAN Abstract Only**
Charles Vest *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 91 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29440*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**FLOW VISUALIZATION OF ACOUSTIC LEVITATION EXPERIMENT**
Ed Baroth *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 93-99 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29441*#** Aerodyne Research, Inc., Billerica, Mass.
**TOWARD AUTOMATED ANALYSIS OF PARTICLE HOLOGRAMS**
H. J. Caulfield *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 101-110 Previously announced in IAA as A85-35204 (For primary document see N87-29432 24-02)
(ARI-RR-449) Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29442*#** National Bureau of Standards, Washington, D.C.
**TEMPERATURE AND CONCENTRATION MEASUREMENTS IN COMBUSTION Abstract Only**
Takashi Kashiwagi *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 115 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29446*#** Stanford Univ., Calif. Dept. of Aeronautics/Astronautics and Electrical Engineering.
**HIGH SPEED OPTICAL TOMOGRAPHY FOR FLOW VISUALIZATION**
Ray Snyder and Lambertus Hesselink *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 171-191 Previously announced in IAA as A86-19160 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29447*#** Aerometrics, Inc., Mountain View, Calif.
**OPTICAL INTERFEROMETRY IN FLUID DYNAMICS RESEARCH**
W. D. Bachalo and M. J. Houser *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 193-247 Previously announced in IAA as A85-35203 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29448*#** Cambridge Univ. (England).
**TRANSONIC FLOW VISUALIZATION USING HOLOGRAPHIC INTERFEROMETRY**
Peter J. Bryanston-Cross *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 261-293 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29449*#** Florida State Univ., Tallahassee. Fluid Mechanics Research Lab.
**THE DEVELOPMENT OF LASER SPECKLE OR PARTICLE IMAGE DISPLACEMENT VELOCIMETRY. PART 1: THE ROLE OF PHOTOGRAPHIC PARAMETERS**
L. M. M. Lourenco and A. Krothapalli *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 295-341 (For primary document see N87-29432 24-02)
(FMRL-TR-1-Pt-1) Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29450*#** Dayton Univ., Ohio. Dept. of Mechanical Engineering.
**COMPUTATIONAL INTERFEROMETRIC DESCRIPTION OF NESTED FLOW FIELDS**
A. George Havener and L. A. Obergefell (Systems Research Labs., Inc., Dayton, Ohio.) *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 343-368 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29451*#** Army Research and Technology Labs., Moffett Field, Calif. Aeromechanics Lab.
**APPLICATION OF DIGITAL INTERFEROGRAM EVALUATION TECHNIQUES TO THE MEASUREMENT OF 3-D FLOW FIELDS**
Friedhelm Becker and Yung Yu, H. *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 369-431 Previously announced in IAA as A85-20852 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29452*#** Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
**THE FRINGE READING FACILITY AT THE MAX-PLANCK-INSTITUT FUER STROEMUNGSFORSCHUNG**
F. Becker, G. E. A. Meier, H. Wegner, R. Timm, and R. Wenskus *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 433-436 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29453*#** Spectron Development Labs., Inc., Costa Mesa, Calif.
**A NEW ART CODE FOR TOMOGRAPHIC INTERFEROMETRY**
H. Tan and D. Modarress *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 437-459 Previously announced in IAA as A85-35201 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29457*#** Spectron Development Labs., Inc., Costa Mesa, Calif.
**PARTICLE FIELD HOLOGRAPHY DATA REDUCTION BY FOURIER TRANSFORM ANALYSIS**
Cecil F. Hess and James D. Trolinger *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 541-564 Previously announced in IAA as A86-32304 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29458*#** Spectron Development Labs., Inc., Costa Mesa, Calif.
**PARTICLE AND FLOW FIELD HOLOGRAPHY: A CRITICAL SURVEY**
James D. Trolinger *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 565-587 (For primary document see N87-29432 24-02)
Avail: NTIS HC A99/MF A01 CSCL 14E

**N87-29478#** Marconi Avionics Ltd., Rochester (England). Guidance Systems Div.
**A LOW COST GYROSCOPE FOR GUIDANCE AND STABILISATION UNITS**
D. G. Harris *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 9 p (For primary document see N87-29474 24-04)
Copyright Avail: NTIS HC A07/MF A01

**N87-29479#** Naval Air Development Center, Warminster, Pa. Strapdown Navigation Lab.
**JOINT DEVELOPMENT OF THE MULTI-FUNCTION INTEGRATED INERTIAL SENSOR ASSEMBLY (MIISA)**
Jack Jankovitz, David Krasnjanski, and Andrew S. Glista, Jr. (Naval Air Systems Command, Washington, D. C.) *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 9 p (For primary document see N87-29474 24-04)
Copyright Avail: NTIS HC A07/MF A01

**N87-29875*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**A CAD/CAE ANALYSIS OF PHOTOGRAPHIC AND ENGINEERING DATA**
S. Michael Goza and Wayne L. Peterson *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 235-246 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 14E

# 36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

**N87-29806#** Lawrence Livermore National Lab., Calif.
**AN OVERVIEW OF COPPER-LASER DEVELOPMENT FOR ISOTOPE SEPARATION**
B. E. Warner 13 Mar. 1987 13 p Presented at the OE/LASE 87, Los Angeles, Calif., 11 Jan. 1987
(Contract W-7405-eng-48)
(DE87-011557; UCRL-96314; CONF-870132-14) Avail: NTIS HC A02/MF A01

We have developed a copper-laser pumped dye-laser system that addresses all of the requirements for atomic vapor laser isotope separation. The requirement for high average power for the laser system has led to the development of copper-laser chains with injection-locked oscillators and multihundred-watt amplifiers. By continuously operating the Laser Demonstration Facility, we gain valuable data for further upgrade and optimization. DOE

**N87-29807#** Lawrence Livermore National Lab., Calif.
**A HIGH GAIN FREE ELECTRON LASER AMPLIFIER DESIGN FOR THE ALCATOR-C TOKAMAK**
R. A. Jong Feb. 1987 34 p
(Contract W-7405-eng-48)
(DE87-011600; UCID-21075) Avail: NTIS HC A03/MF A01

We describe an improved wiggler tapering algorithm and the resulting wiggler design for a high-gain free electron laser amplifier to be used for plasma heating and current drive experiments in the Alcator-C tokamak. Unlike the original, this new design limits the growth of the shot noise to insignificant levels. The design goal of at least 8 GW of peak power in the TE sub 01 mode was achieved wit h a 3 kA electron beam with energies in the 7 to 9 MeV range and a beam brightness of 10,000 A/(rad-cm)$^2$. The wiggler was 5 m long with a wiggler wavelength of 8 cm. DOE

**N87-29808#** Lawrence Livermore National Lab., Calif.
**OPTICAL GUIDING AND BEAM BENDING IN FREE-ELECTRON LASERS**
E. T. Scharlemann 1987 41 p Presented at the OE/LASE '87, Los Angeles, Calif., 11 Jan. 1987
(Contract W-7405-eng-48)
(DE87-010814; UCRL-96329; CONF-870132-8) Avail: NTIS HC A03/MF A01

The electron beam in a free-electron laser (FEL) can act as an optical fiber, guiding or bending the optical beam. The refractive and gain effects of the bunched electron beam can compensate for diffraction, making possible wigglers that are many Rayleigh ranges (i.e., characteristic diffraction lengths) long. The origin of optical guiding can be understood by examining gain and refractive guiding in a fiber with a complex index of refraction, providing a mathematical description applicable also to the FEL, with some extensions. In the exponential gain regime of the FEL, the electron equations of motion must be included, but a self-consistent description of exponential gain with diffraction fully included becomes possible. The origin of the effective index of refraction of an FEL is illustrated with a simple example of bunched, radiating dipoles. Some of the properties of the index of refraction are described. The limited experimental evidence for optical beam bending is summarized. The evidence does not yet provide conclusive proof of the existence of optical guiding, but supports the idea. Finally, the importance of refractive guiding for the performance of a high-gain tapered-wiggler FEL amplifier is illustrated with numerical simulations. DOE

**N87-29809#** European Physical Society, Geneva (Switzerland).
**DEVELOPMENT OF A Nd:YLF SOLID STATE LASER**
R. do AmaralNeto and S. P. Morato 1986 1 p Presented at the 5th Europhysical Topical Conference on Lattice Defects in Ionic Materials, Madrid, Spain, 8 Sep. 1986
(DE87-702482; INIS-BR-647; CONF-8609138-6-Summ) Avail: NTIS (US Sales Only) HC A02/MF A01

Continuous wave (CW) laser action was obtained at room temperature of a Nd:YLF crystal in an astigmatically compensated cavity, pumped by an argon laser. Through the study of the optical properties of the Nd:YLF crystal, its laser operation was predicted using a small volume gain medium on the mentioned cavity, pumped by an Ar 515.5 micron laser line. To obtain the laser action at polarizations sigma (1.053 microns) and pi (1.047 microns), an active medium was prepared which was a crystalline plate with a convenient crystallographic orientation. The laser characterization is in reasonable agreement with the initial predictions. For a 3.51 output mirror transmission, the oscillation threshold is about 0.15 W incident on the crystal, depending upon the sample used. For 1 W of incident pump light, the output power is estimated to be 12 mW, which corresponds to almost 1.5 percent slope efficiency. The versatile arrangement is applicable to almost all optically pumped solid state laser materials. B.G.

**N87-29810#** Israel Atomic Energy Commission, Beersheba. Nuclear Research Center.
**COMBINING LASER BEAMS BY DISPERSIVE PRISM**
Haim Lotem and Shimon Lavi May 1986 8 p In HEBREW; ENGLISH summary
(DE87-702854; NRCN-572) Avail: NTIS (US Sales Only) HC A02/MF A01

A method of combining laser beams with different wavelengths, by Brewster angle dispersive prism made of SrTiO crystal is presented. Such a prism permits combining beams with a 5 micron difference in the red; it has minimal absorption losses and a high damage threshold. DOE

**N87-29811#** Pacific Northwest Labs., Richland, Wash.
**HIGH-EFFICIENCY, HIGH ABUNDANCE SENSITIVITY RIMS BY DOUBLE-RESONANCE EXCITATION WITH CW-LASERS**
B. A. Bushaw, B. D. Cannon, G. K. Gerke, and T. J. Whitaker Aug. 1986 7 p Presented at the Resonance Ionization Spectroscopy and Its Application, Swansea, England, 7 Sep. 1986
(Contract DE-AC06-76RL-01830)
(DE87-012060; PNL-SA-13786; CONF-8609132-16) Avail: NTIS HC A02

Two single-frequency CW dye lasers and a medium power infrared CW laser have produced efficient, highly selective ionization of barium isotopes in the source region of a quadrupole mass spectrometer. Laser ionization efficiencies of greater than 5% have been observed while maintaining isotopic selectivities of approx. 10 y. DOE

**N87-29812#** Battelle Inst., Frankfurt am Main (West Germany).
**COHERENT CO2 PULSED LASER RADAR FOR CLIMATOLOGY AND METEOROLOGY, PHASE A Final Report, Sep. 1984**
Martin Endemann Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 197 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-W-86-024; ISSN-0170-1339; ETN-87-90326) Avail: NTIS HC A09/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 36

Applications of a CO2 pulse radar (lidar) with coherent detection, for climatological and meteorological measurements, were examined. Expressions concerning the measurement accuracy were derived, including the effects of incoherent backscatter (speckle) and atmospheric turbulence (phase fluctuations and scintillations). Requirements for pulse energy and pulse repetition frequency of the transmitting laser were deduced. A transmitting laser with a high pulse repetition frequency but comparatively low pulse energy is ideal for this application. The comparison between the measurement sensitivity of a lidar and that of a comparable direct detecting instrument clearly shows the advantage of the more complex receiver. Measurements from satellites are only feasible with a coherent lidar. Wind velocity profiles are the most important measurement objective for climatology and meteorology. A coherent wind sensor can be designed to determine additional atmospheric parameters with the same instrument. ESA

**N87-29813#** California Univ., Santa Barbara. Dept. of Physics.
**FREE-ELECTRON LASER RESEARCH AT THE UNIVERSITY OF CALIFORNIA, SANTA BARBARA**
Luis R. Elias 1987 20 p
(Contract N00014-86-K-0692)
(AD-A182987) Avail: NTIS HC A02/MF A01 CSCL 09C

A review of free-electron laser research is presented. Among the topics included are: (1) the development of high-quality electron beam sources based on electrostatic accelerating fields, (2) the analysis of present FEL operating characteristics, (3) the development of advanced FEL concepts, and (4) the utilization of the FEL in scientific research. GRA

**N87-29814#** Naval Research Lab., Washington, D.C.
**LASER PROCESSING OF HIGH-TECH MATERIALS AT HIGH IRRADIANCE**
Robert R. Whitlock 13 May 1987 23 p
(AD-A183022; NRL-MR-5915) Avail: NTIS HC A02/MF A01 CSCL 09C

The major applications of lasers to the processing of high technology materials are briefly enumerated. It is found that the majority of these applications rely upon the direct thermal effects of irradiating the material with laser light. Several other important interactions of high irradiance lasers with materials are examined. The need for survey and evaluation of the capabilities of lasers to generate shocks for materials processing is underscored. Emphasis is placed on applications and potential applications of secondary processing, in which the particle or phonon emissions of a laser-produced plasma are employed in the materials processing steps. The demonstrated feasibility of using X-ray pulses from laser-produced plasmas for X-ray lithographic fabrication of microelectronics and microstructures is briefly reviewed. The possible application of laser evaporative deposition to the fabrication of novel materials, such as multilayers, superlattices, quantum device microstructures, is proposed. GRA

**N87-29815#** Naval Research Lab., Washington, D.C.
**OPTICAL GAIN, PHASE SHIFT AND PROFILE IN FREE-ELECTRON LASERS Interim Report**
B. Hafizi, Phillip A. Sprangle, and A. Ting 20 Jul. 1987 49 p
(AD-A183072; NRL-MR-5998) Avail: NTIS HC A03/MF A01 CSCL 09C

The gain, phase shift, wavefront curvature and radius of the radiation envelope in a free electron laser amplifier are obtained in the small signal regime. The electron beam is assumed to have a Gaussian density distribution in the transverse direction. Numerical calculations indicate that the radius and curvature of the radiation beam entering a wiggler asymptote to unique, spatially constant values after a finite transition region. However, in the asymptotic region the wavefronts are divergent. Analytical expressions for the gain, phase shift, curvature and spot size and derived. It is shown analytically that small perturbations of the optical waist and curvature about the matched value are spatially damped out, indicating the stability of the matched envelope. When the electron beam envelope is modulated in space, the optical spot size oscillates with an almost identical wavelength but is delayed in phase. In the case of small amplitude long wavelength betatron modulation of the electron beam envelope, generation of optical sidebands in wave number space is examined and the effect on the dispersions characteristic of the primary wave is found to be negligible for typical experimental parameters. GRA

**N87-29816#** Naval Research Lab., Washington, D.C.
**NONLINEAR THEORY OF THE ORBITRON MASER IN THREE-DIMENSIONS**
A. K. Ganguly, H. P. Freund, and Saeyoung Ahn 30 Jun. 1987 31 p
(AD-A183073; NRL-MR-5979) Avail: NTIS HC A03/MF A01 CSCL 09C

The nonlinear analysis of the Orbitron Maser is studied numerically for an amplifier configuration in which an electron beam propagates through a coaxial waveguide with a voltage applied between the inner and out conductors. A set of coupled nonlinear differential equations is derived in three dimensions which governs the self consistent evolution of either the TE, TM, or TEM modes in a loss-free coaxial waveguide as well as the trajectories of an ensemble of electrons. The saturation efficiency as well as the linear growth rate are calculated and, although the linear growth rate for the orbitron amplifier is moderately high (about 1.0 dB/cm), the efficiency is low (somewhat less than 6.1 percent). Severe limitations arise in the high frequency operation of the orbitron amplifier in the fundamental mode due to the break-down electric field and extremely small radius of the inner conductor. GRA

**N87-29817#** Virginia Commonwealth Univ., Richmond.
**BIOLOGICAL APPLICATIONS AND EFFECTS OF OPTICAL MASERS Final Report, 16 Mar. - 15 Oct. 86**
William T. Ham, Jr., Harold A. Mueller, John J. Ruffolo, Jr., Stephan F. Cleary, and R. K. Guerry Apr. 1987 48 p
(Contract DAMD17-82-C-2083; DA Proj. 3E1-62777-A-878)
(AD-A183462) Avail: NTIS HC A03/MF A01 CSCL 06G

The literature pertaining to retinal light damage from environmental and man-made optical sources prior to the last decade is reviewed with particular attention to acute and long-term chronic exposure leading to thermal and photochemical lesions of the retina. The parameters of wavelength, exposure time and power level are given as the major factors defining thermal vs photochemical damage. Light toxicity as a function of wavelength is dealt with in some detail. In particular, wavelengths ranging from 1064 nm to 325 nm in the near ultraviolet are studied using macaque monkeys. Exposures in the near UV were accomplished using aphakic monkeys (lens removed surgically). The histopathologies of blue light and near ultraviolet lesions of the retina in the macaque monkey are described. Light damage to the RPE and its possible relationship to aging and macular degeneration is investigated. GRA

**N87-29818#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**A SUPERCONDUCTING MAGNET SYSTEM FOR FREE-ELECTRON CYCLOTRON MASER (SELECTED PORTIONS)**
Yong Zhang, Guangzhen Gao, Zhikai Wang, Shuyuan Wang, and Xiufen Qiao 12 Aug. 1987 9 p Transl. into ENGLISH from Danzixue Tongxun (China), no. 2, 1986 p 151-154
(AD-A183829; FTD-ID(RS)T-1058-86) Avail: NTIS HC A02/MF A01 CSCL 09C

The superconducting magnet system is an important part of the free-electron cyclotron maser. A new superconducting magnet system is designed and tested. It consists of a main superconducting magnet, a gradient superconducting magnet, a normal magnet, a cryostat and some other accessories. The advantages of the designated magnet system are small in size, high stable magnet field and suitable field profile. It is very suitable for 4 mm wave free-electron cyclotron maser. GRA

**N87-29819#** Plasma Research Corp., Alameda, Calif.
**LASER INDUCED EMP (ELECTROMAGNETIC PULSE) AT 10.6 MICRONS Final Report, Jan. 1984 - Jun. 1986**
Glen Dahlbacka and John Guillory May 1987 137 p
(Contract F33615-85-C-3405)
(AD-A183892; PRC-FR-86-01; AFWAL-TR-87-3034) Avail: NTIS HC A07/MF A01 CSCL 20O

An extensive experimental session was analyzed (1200 shots) to investigate the behavior of Laser Induced Electromagnetic Pulse (LIEMP) parametrically with CO2 laser intensity within a decade of 10 GW/sq cm and with air pressure from 1 microtorr to a torr. Measured electric fields on a ground plane and current measured 3 cm from the target were compared to theory. One hundred eV suprathermal electrons (1.6 keV maximum energy) create the LIEMP after laser light, self-focussed a few fold, is resonantly absorbed. The model predicts electric field scaling as Intensity(1/2) as observed, but current scaling is not reproduced. The electric fields are no threat for CO2 and shorter wavelengths, but may pose a threat for millimeter waves. Pressure dependencies are reproduced with classical energy loss in gasses. GRA

**N87-29820*#** Hampton Inst., Va. Dept. of Physics and Engineering.
**DIRECT SOLAR-PUMPED IODINE LASER AMPLIFIER Semiannual Progress Report, 1 Mar. - 30 Sep. 1987**
Kwang S. Han 21 Oct. 1987 43 p
(Grant NAG1-441)
(NASA-CR-181391; NAS 1.26:181391) Avail: NTIS HC A03/MF A01 CSCL 20E

This semiannual progress report covers the period from March 1, 1987 to September 30, 1987 under NASA grant NAG1-441 entitled 'Direct solar-pumped iodine laser amplifier'. During this period Nd:YAG and Nd:Cr:GSGG crystals have been tested for the solar-simulator pumped cw laser, and loss mechanisms of the laser output power in a flashlamp-pumped iodine laser also have been identified theoretically. It was observed that the threshold pump-beam intensities for both Nd:YAG and Nd:Cr:GSGG crystals were about 1000 solar constants, and the cw laser operation of

the Nd:Cr:GSGG crystal was more difficult than that of the Nd:YAG crystal under the solar-simulator pumping. The possibility of the Nd:Cr:GSGG laser operation with a fast continuously chopped pumping was also observed. In addition, good agreement between the theoretical calculations and the experimental data on the loss mechanisms of a flashlamp-pumped iodine laser at various fill pressures and various lasants was achieved. Author

**N87-29475#** Eltro G.m.b.H., Heidelberg (West Germany).
**EYE SAFE RAMAN LASER RANGE FINDER FOR GROUND AND AIRBORNE APPLICATION**
J. Ruger *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 9 p (For primary document see N87-29474 24-04)
Copyright Avail: NTIS HC A07/MF A01

**N87-30148#** Joint Publications Research Service, Arlington, Va.
**NONLINEAR CONVERSION OF CONTINUOUS RADIATION BY STIMULATED-SCATTERING WAVEGUIDE LASERS Abstract Only**
Ye. M. Dianov, A. N. Pilipetskiy, A. M. Prokhorov, and V. N. Serkin *In its* USSR Report: Physics and Mathematics 9 Apr. 1987 p 22 Transl. into ENGLISH from Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki (Moscow, USSR), v. 91, no. 4(10), Oct. 1986 p 1249-1261 (For primary document see N87-30145 24-70)
Avail: NTIS HC A04/MF A01

# 37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

**N87-29821#** Sandia National Labs., Albuquerque, N. Mex.
**MOBILE ROBOT VEHICLES FOR PHYSICAL SECURITY**
D. E. McGovern Jul. 1987 9 p
(Contract DE-AC04-76DP-00789)
(DE87-012843; SAND-87-0948) Avail: NTIS HC A02/MF A01

A fleet of vehicles is being developed and maintained by Sandia National Labs for studies in remote control and autonomous operation. These vehicles range from modified commercial vehicles to specially constructed mobile platforms and are utilized as test beds for developing concepts in the application of robotics to interior and exterior physical security. Actuators control the vehicle speed, brakes, and steering through manual input from a remote driving station or through some level of digital computer control. On-board processing may include simple vehicle control functions or may allow for unmanned, autonomous operation. Communication links are provided for digital communication between control computers, television transmission for vehicle vision, and voice for local control. With these vehicles, SNL can develop, test, and evaluate sensors, processing requirements, various methods of actuator implementation, operator controlled feedback requirements, and vehicle operations. A description of the major features and uses for each of the vehicles in the fleet is provided. DOE

**N87-29822#** Japan Atomic Energy Research Inst., Tokyo.
**INVERSE KINEMATICS OF A MANIPULATOR. THE INVERSE JACOBIAN METHOD AND TREATMENT AT SINGULAR POINTS**
Tomoaki Suzudo Aug. 1986 37 p In JAPANESE
(DE87-702522; JAERI-M-86-123) Avail: NTIS (US Sales Only) HC A03/MF A01

The inverse Jacobian method based on the linearization of manipulator kinematics equation is generally used for obtaining its inverse kinematic solutions. In the present study, a robot manipulator having 6 degrees of freedom is analyzed for specified positions and orientations and the accuracies and limitations of the method are discussed. Generally speaking, the inverse Jacobian method cannot be applied when it is singular. However, it is possible to find a regular minor matrix and to obtain its inverse transformation. Based on this concept, a method has been developed which can be applied for obtaining the inverse transformation for manipulators at their singular points. It has been confirmed that the present method can give inverse kinematic solutions for manipulators with the same order of accuracy at singular points as those obtained at nonsingular points from a practical view point. DOE

**N87-29823#** Sandia National Labs., Albuquerque, N. Mex.
**REACHABLE WORKSPACE OF TWO PLANAR 3R COOPERATING MANIPULATORS**
R. D. Palmquist and J. Duffy 1987 7 p Presented at the ASME Computers in Engineering Conference, New York, N.Y., 9 Aug. 1987 Prepared in cooperation with Florida Univ., Gainesville
(Contract DE-AC04-76DP-00789)
(DE87-007863; SAND-87-0810C; CONF-870852-2) Avail: NTIS HC A02/MF A01

The issue of having adjacent manipulators cooperate with each other in performing a given task has received increasingly more attention over the past few years. These manipulators could be on a manufacturing line, perhaps the legs of a walking machine, or even the fingers of a mechanical hand. In each case, the same type of geometric and kinematic analysis can apply. In this paper the reachable workspace associated with such a manipulator pair is addressed. By way of example, two planar 3R robots operating in tandem are used. This then provides a foundation for extension to other types of planar and spatial manipulators. DOE

**N87-29824#** Lawrence Livermore National Lab., Calif.
**THE EFFECT OF THE FAILURE CRITERION IN THE NUMERICAL MODELING OF ORTHOGONAL METAL CUTTING Abstract Only**
R. A. Riddle Apr. 1987 34 p Presented at the IMOG Metal Forming Modeling Subgroup, Livermore, Calif., 22 Apr. 1987
(Contract W-7405-eng-48)
(DE87-010806; UCRL-93745; CONF-8704116-2) Avail: NTIS HC A03/MF A01

Numerical modeling of metal cutting using the finite element method has been successfully used to show that assumed material properties have a large effect on such machining process parameters as the required tool forces, chip morphology, and residual stresses in the finished surface. Finite element results show that workpiece material properties such as assumed isotropic or kinematic hardening, the work hardening and work softening stress-strain behavior, the friction factor between the tool and the workpiece materials, and the failure criterion for the workpiece material all have a significant effect on the predicted cutting forces, chip shape, and workpiece residual stresses. The failure criterion for the workpiece material in the numerical modeling is used to describe the separation of the chip from the workpiece at the tool tip. DOE

**N87-29825#** Oak Ridge National Lab., Tenn.
**NEURAL NETWORK REPRESENTATION OF SENSOR GRAPHS IN AUTONOMOUS ROBOT PATH PLANNING**
C. C. Jorgensen 1987 9 p Presented at the 1st IEEE International Conference on Neural Networks, San Diego, Calif., 21 Jun. 1987
(Contract DE-AC05-84OR-21400)
(DE87-011125; CONF-8706130-1) Avail: NTIS HC A02/MF A01

This paper discusses a continuous valued associative neural network used for anticipatory robot navigation planning in partially learned environments. A navigation methodology is implemented in four steps. First, a room is represented as a lattice of connected voxels formed by dividing navigation space into equal sized volumetric cells. Each voxel is associated with a simulated neuron. The magnitude of a neurons activation corresponds to a probability of voxel occupancy calculated from a series of sonar readings taken by an autonomous robot. Neurons are trained with a series of room patterns derived from varying robot sensor perspectives.

At another time, the robot is exposed to a single perspective of one of the rooms and utilizes the sensor return as a cue to prompt associative recall of a best guess of the complete interior of the room. A two step path planning operation is then invoked which uses line of sight readings and anticipated global information to form a trial path plan. The planning process merges a nearest neighbor grid cell technique and a simulated annealing gradient descent method to optimize traversal movements. In the final step, the path is followed until a mismatch between the estimated room and the actual sensor returns indicate incorrect anticipation. Implementation of the method on a Hypercube computer is discussed along with memory computation tradeoff requirements. DOE

**N87-29826#** Pacific Northwest Labs., Richland, Wash.
**DESIGN OF A DISTRIBUTED CONTROL SYSTEM FOR A ROBOTIC MANNEQUIN**
R. W. Gilbert, R. L. Cheatham, P. J. Hof, and G. A. Anderson Feb. 1987 7 p Presented at the International Topical Meeting on Remote Systems and Robotics in Hostile Environments, Pasco, Wash., 29 Mar. 1987
(Contract DE-AC06-76RL-01830)
(DE87-011157; PNL-SA-14058; CONF-870301-23) Avail: NTIS HC A02

A robotic mannequin with thirty-eight degrees of movement freedom has been designed and is currently being developed by engineers at Pacific Northwest Laboratory. The mannequin will be used to test the effectiveness of protective clothing in hazardous environments. By simulating human movements and positions, the mannequin will be able to test the effectiveness of protective clothing in a realistic, workplace environment. The accuracy afforded by the mannequin has not been possible to date without using human testers. In addition to this realistic environment, reproducible and standardized testing will be achieved by using the mannequin's programmed and repetitive test routines. During testing, special sensors will detect any penetration of the protective clothing by the hostile environment. The robotic mannequin's control system provides the control and monitoring functions necessary to allow coordinated movement of multiple joints and also controls the ancillary systems: breathing, perspiration, skin heating, sampling of chemical reagents, and test data recording. DOE

**N87-29827#** Argonne National Lab., Ill.
**RELIABILITY STUDY OF STIRLING ENGINES FOR SOLAR DISH/HEAT ENGINE SYSTEMS**
R. E. Holtz and K. L. Uherka May 1987 9 p Presented at the 22nd Intersociety Energy Conversion Engineering Conference, Philadelphia, Pa., 10 Aug. 1987
(Contract W-31-109-eng-38)
(DE87-011387; CONF-870804-15) Avail: NTIS HC A02

The objective of this study was to examine the reliability of existing and improved Stirling engine concepts for dispersed solar dish-electric applications in the 25 to 50 kWe range. Five current kinematic Stirling engine designs have the capability to meet or exceed the 32% efficiency goal of the DOE Solar Thermal Program. A review of historical Stirling engine data illustrated that the three major reliability issues with kinematic Stirling engines are the piston-rod seals, engine hot parts (i.e., heater head, regenerator and cylinders) and power control/drive system. The most significant reliability issue associated with achieving the 50,000 hour operating life goal involves piston-rod seals. A specific kinematic engine concept that appears to have the potential for meeting the 50,000 hour operating lifetime requirement of solar power systems is the STM4-120 engine. This engine has a pressurized crankcase to reduce piston-rod seal problems, an indirect heat pipe hot-end section to smooth out temperature gradients in the heater tubes, and a variable angle swashplate for power control. DOE

**N87-29828#** Sandia National Labs., Albuquerque, N. Mex.
**DEXTERITY OF TWO PLANAR 3R COOPERATING ROBOTS**
R. D. Palmquist and J. Duffy (Florida Univ., Gainesville.) 1987 8 p Presented at the ASME Computers in Engineering Conference, New York, N.Y., 9 Aug. 1987
(Contract DE-AC04-76DP-00789)
(DE87-007843; SAND-87-0864C; CONF-870852-1) Avail: NTIS HC A02/MF A01

The reachable and dexterous workspaces are significant parameters in evaluating the performance characteristics of a given manipulator. This also applies to manipulator pairs working together to perform a given task. This task could be assembling a workpiece on a manufacturing line, working the fingers of a mechanical hand in harmony to pick up an object, or perhaps coordinating the motion of the legs of a walking machine. In each case, optimizing these workspaces becomes important. In the companion paper, Reachable Workspace of Two Planar 3R Cooperating Manipulators, the reachable workspace of these manipulator pairs was addressed. Here, the issue of dexterity is investigated. Specifically, the dexterous properties of a single planar 3R manipulator are reviewed. Building on these ideas, the dexterity of a pair of these planar robots is then analyzed. In accomplishing this, we define the term tandem dexterity and classify the different dexterity forms. We present some applications of this dexterity analysis, showing how it can be used in typical tasks employing such manipulator pairs. DOE

**N87-29829#** Sandia National Labs., Albuquerque, N. Mex.
**THE ROLE OF THE METAL VAPOR PLUME IN PULSED Nd:YAG LASER WELDING ON ALUMINUM 1100**
H. C. Peebles and R. L. Williamson 1987 16 p Presented at the International Conference on Laser Advanced Materials Processing: Science and Applications, Osaka, Japan, 21 May 1987
(Contract DE-AC04-76DP-00789)
(DE87-008507; SAND-86-2219C; CONF-8705130-1) Avail: NTIS HC A02

Two possible mechanisms for laser power absorption in the metal vapor plume formed during Nd:YAG laser welding on commercially pure aluminum are examined. Results of emission spectroscopy of the plume indicate that the maximum electron density in the plume is too low to result in significant free-free absorption of the incident laser radiation. Particle condensation in the plume is observed. However, light scattering experiments indicate that the particles do not appear in the optical path of the weld laser during the period of the laser pulse. DOE

**N87-29830#** Pacific Northwest Labs., Richland, Wash.
**DESIGN, CONSTRUCTION, AND TESTING OF AN ANTHROPOMORPHIC ROBOT**
D. W. Bennett and J. A. Yount Oct. 1986 14 p Presented at the International Topical Meeting on Remote Systems and Robotics in Hostile Environments, Pasco, Wash., 29 Mar. 1987
(Contract DE-AC06-76RL-01830)
(DE87-011141; PNL-SA-14440; CONF-870301-24) Avail: NTIS HC A02/MF A01

The objective of the mannequin project is to provide a poseable anthropomorphic robot for use in experimental studies of the effectiveness of protective clothing in hostile environments. The effects of wear and exercise of protective clothing will be evaluated with respect to the effects of body articulation, representative skin temperature, perspiration, and breathing. The mannequin will serve two primary functions. First, it will be used to study penetration of the protective clothing by the hostile environment. The mannequin will be outfitted with a variety of clothing and equipment to serve this function. Second, the mannequin will be capable of anthropomorphically and repetitively exercising a variety of protective clothing and equipment in simulated and variable field conditions without committing man to the hostile environment. DOE

**N87-29831#** Oak Ridge National Lab., Tenn.
**EXPERIMENTS IN AUTONOMOUS ROBOTICS**
W. R. Hamel 1987 7 p Presented at the 5th Symposium on Energy Engineering Sciences, Argonne, Ill., 17 Jun. 1987
(Contract DE-AC05-84OR-21400)
(DE87-010893; CONF-870679-2; CESAR-87/21) Avail: NTIS HC A02/MF A01

(DE87-010893; CONF-870679-2; CESAR-87/21) Avail: NTIS HC A02/MF A01

The Center for Engineering Systems Advanced Research (CESAR) is performing basic research in autonomous robotics for energy-related applications in hazardous environments. The CESAR research agenda includes a strong experimental component to assure practical evaluation of new concepts and theories. An evolutionary sequence of mobile research robots has been planned to support research in robot navigation, world sensing, and object manipulation. A number of experiments have been performed in studying robot navigation and path planning with planar sonar sensing. Future experiments will address more complex tasks involving three-dimensional sensing, dexterous manipulation, and human-scale operations. DOE

**N87-29832#** Sandia National Labs., Albuquerque, N. Mex.
**EXPERIMENTAL AND ANALYTICAL STUDY OF AN ARC WELDING PROCESS**

R. L. Akau, G. W. Krutz, and R. J. Schoenhals 23 Jun. 1987 14 p Presented at the 5th International Conference on Numerical Methods for Thermal Problems, Montreal, Quebec, 29 Jun. 1987 Prepared in cooperation with Purdue Univ., Lafayette, Ind.
(Contract DE-AC04-76DP-00789)
(DE87-011094; SAND-87-0875C; CONF-8706110-2) Avail: NTIS HC A02/MF A01

This investigation involves both an experimental study of a GTAW (Gas Tungsten Arc Welding) process and the development of a numerical heat transfer model for the base material. Measured and calculated results will be compared to validate the thermal model. Actual welding (i.e., joining of metals) is not performed in this study. The welding process consists of just passing the arc over the base material. However, the results obtained can be readily applied to actual welding conditions. DOE

**N87-29833#** Illinois Univ., Urbana. Dept. of Mechanical and Industrial Engineering.
**VIBRATIONAL STABILIZABILITY OF A CLASS OF DISTRIBUTED PARAMETER SYSTEMS**

J. Bentsman, S. M. Meerkov, and Xianshu Shu 1986 3 p Presented at the IFAC Symposium on Distributed Parameter Systems, Los Angeles, Calif., 1 Jun. 1986 Prepared in cooperation with Michigan Univ., Ann Arbor and Illinois Inst. of Tech., Chicago
(Contract DE-FG02-85ER-13315)
(DE87-011170; CONF-8606315-1) Avail: NTIS HC A02/MF A01

A number of experimental and theoretical results reported in the current literature demonstrate stabilization of DPS (distributed parameter systems) by the introduction of zero mean oscillations in their parameters. Stability analysis in each case, however, is based on the specificities of a model under consideration. The present paper introduces a method of stability analysis for a class of DPS and derives a set of conditions of vibrational stabilizability. DOE

**N87-29834#** Illinois Univ., Urbana. Dept. of Mechanical and Industrial Engineering.
**VIBRATIONAL CONTROL OF NONLINEAR PARABOLIC SYSTEMS**

J. Bentsman, S. M. Meerkov, and Xianshu Shu 1987 5 p Presented at the 10th IFAC World Congress on Automatic Control, Munich, West Germany, 27 Jul. 1987 Prepared in cooperation with Michigan Univ., Ann Arbor and Illinois Inst. of Tech., Chicago
(Contract DE-FG02-85ER-13315)
(DE87-011171; CONF-870742-2) Avail: NTIS HC A02

Vibrational control is a non-classical control principle which proposes utilization of zero mean parametric excitation of a dynamical system to achieve control objectives. The present paper is devoted to the development of vibrational control theory of nonlinear infinite dimensional systems described by parabolic partial differential equations (PDE's). Conditions of vibrational stabilizability of nonlinear parabolic PDE's by linear multiplicative vibrations are given. DOE

**N87-29835#** Michigan Univ., Ann Arbor. Dept. of Electrical Engineering and Computer Science.
**VIBRATIONAL FEEDBACK CONTROL**

S. M. Meerkov 1986 9 p Presented at the 4th Symposium on Energy Engineering Sciences: Chemical Processes and Control - Non-Linear Systems, Argone, Ill., 7 May 1986
(Contract DE-FG02-85ER-13315)
(DE87-011173; CONF-8605122-5) Avail: NTIS HC A02/MF A01

This paper illustrates that in addition to closed loop pole placement, vibrational feedback control leads to a possibility of open loop zeros assignability. On this basis, the superior performance characteristics of periodic controllers are explained. DOE

**N87-29836#** Sandia National Labs., Albuquerque, N. Mex.
**METAL SURFACE GOUGING BY HYPERVELOCITY SLIDING CONTACT**

L. M. Barker, T. G. Trucano, and J. W. Munford 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-012371; SAND-87-0850C; CONF-870753-26) Avail: NTIS HC A02/MF A01

Surface gouging due to hypervelocity sliding contact occurs above certain threshold velocities in hypervelocity gun barrels and on the rails of rocket-propelled sleds. A theory for the mechanism of gouging damage is tested by computer simulation of the dynamic gouge initiation and growth phases. In addition to agreeing with the observations, parameter variations indicated design concepts which result in gouge-mitigating shoes for rocket sleds. DOE

**N87-29837#** Los Alamos National Lab., N. Mex.
**SPALL MEASUREMENTS IN SHOCK-LOADED HEMISPHERICAL SHELLS FROM FREE-SURFACE VELOCITY HISTORIES**

D. J. Cagliostro, R. H. Warnes, N. L. Johnson, and R. K. Fujita 1987 5 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract W-7405-eng-36)
(DE87-013144; LA-UR-87-2292; CONF-870753-47) Avail: NTIS HC A02/MF A01

Copper and tantalum hemishells are externally loaded by a hemishell of PBX 9501 detonated at its pole. Free-surface velocity histories of the metal hemishells are measured at the pole and at 50° from the pole with a Fabry-Perot interferometer. These histories are used to determine spall strengths and depths by simple wave-interaction analyses and are compared with hydro-code (CAVEAT) predictions using simple and void-growth spall models. DOE

**N87-29838#** Sandia National Labs., Albuquerque, N. Mex.
**GTA WELD PENETRATION AND THE EFFECTS OF DEVIATIONS IN MACHINE VARIABLES**

W. H. Giedt Jul. 1987 46 p
(Contract DE-AC04-76DR-00789)
(DE87-013410; SAND-87-8221) Avail: NTIS HC A03/MF A01

Analytical models for predicting the temperature distribution during gas tungsten arc (GTA) welding are reviewed with the purpose of developing a procedure for investigating the effects of deviations in machine parameters. The objective was to determine the accuracy required in machine settings to obtain reproducible results. This review revealed a wide range of published values (21 to 90 percent) for the arc heating efficiency. Low values (21 to 65 percent) were associated with evaluation of efficiency using constant property conduction models. Values from 75 to 90 percent were determined from calorimetric type measurements and are applicable for more accurate numerical solution procedures. Although numerical solutions can yield better overall weld zone predictions, calculations are lengthy and complex. In view of this and the indication that acceptable agreement with experimental measurements can be achieved with the moving-point-source

solution, it was utilized to investigate the effects of deviations or errors in voltage, current, and travel speed on GTA weld penetration. Variations resulting from welding within current goals for voltage (+/- 0.1 V), current (+/- 3.0 A), and travel speed (+/- 2.0%) were found to be +/- 2 to 4%, with voltage and current being more influential than travel speed. DOE

**N87-29839#** Karlsruhe Univ. (West Germany). Inst. fuer Informatik 3.

**PRELIMINARY INVESTIGATIONS OF THE COUPLING OF CAD SYSTEMS TO VISION SYSTEMS FOR ROBOTS Final Report, Apr. 1985**

Paul Levi, Thomas Loeffler, and Margit Pfitzer Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 179 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-DV-86-010; ISSN-0170-9011; ETN-87-90332) Avail: NTIS HC A09/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 34.50

The coupling of CAD systems to image processing and assembly control systems was investigated. The present models and data systems used in CAD cannot fulfil the requirements of such systems for vision and assembly control. However, the investigation of design of the steps in the construction phase show that they allow efficient support of the vision and assembly control systems. Based on the results of the study of the assembly control, a systems and model structure, which integrates the components necessary for assembly (especially vision and other sensors) is proposed. Systems of this kind are more intelligent and thus more autonomous. ESA

**N87-29840*#** Michigan Technological Univ., Houghton. Dept. of Mechanical Engineering and Engineering Mechanics.

**AN INVESTIGATION OF THE DYNAMIC RESPONSE OF SPUR GEAR TEETH WITH MOVING LOADS Final Report**

C. E. Passerello and L. W. Shuey Aug. 1987 238 p (Grant NAG3-344)
(NASA-CR-179643; NAS 1.26:179643; AVSCOM-TR-87-C-23) Avail: NTIS HC A11/MF A01 CSCL 13I

Two concepts relating to gear dynamics were studied. The first phase of the analysis involved the study of the effect of the speed of a moving load on the dynamic deflections of a gear tooth. A single spur gear tooth modelled using finite elements was subjected to moving loads with variable velocities. The tooth tip deflection time histories were plotted, from which it was seen that the tooth tip deflection consisted of a quasistatic response with an oscillatory response superimposed on it whose amplitude was dependent on the type of load engagement. Including the rim in the analysis added flexibility to the model but did not change the general behavior of the system. The second part of the analysis involved an investigation to determine the effect on the dynamic response of the inertia of the gear tooth. A simplified analysis using meshing cantilever beams was used. In one case, the beams were assumed massless. In the other, the mass (inertia) of the beams was included. From this analysis it was found that the inertia of the tooth did not affect the dynamic response of meshing cantilever beams. Author

**N87-29841#** Lancaster Univ. (England). Dept. of Physics.

**FINE-SCALE MECHANICAL PROPERTIES OF SLIDING SOLIDS Final Technical Report, 12 Mar. 1984 - 12 Dec. 1986**

J. D. Ross and H. M. Pollock 28 Feb. 1987 94 p
(Contracts DAJA45-84-C-0006; DA Proj. 1L1-61102-BH-57)
(AD-A182940; R/D-4106-R-AN) Avail: NTIS HC A05/MF A01 CSCL 20K

This report describes fine-scale contact experiments specifically designed to investigate the mechanical properties of materials at the submicroscopic level. The first part deals with experiments carried out using an ultra-high vacuum (UHV) mechanical microprobe, in which adhesion and friction are measured between a sharply-pointed metal tip and a flat surface at very light loads. The results show that, for a metal-metal or metal-ceramic interface, the adhesion and frictional resistance to tangential sliding are highest for clean surfaces in UHV. However, for contacts between a metal tip and an amorphous metallic glass both adhesion and friction are lower after standard cleaning procedures in UHV. Part 2 describes fine-scale indentation measurements on thin films and ion-implanted surfaces carried out in the laboratory ambient. It is shown that surface layers less than a few hundred nm thickness can be successfully characterized in terms of plastic, elastic and time-dependent properties. GRA

**N87-29842#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

**REAL TIME SIMULTANEOUS IN-LINE WEAR AND LUBRICANT CONDITION MONITORING Final Report, Jun. 1986 - Dec. 1986**

Phillip W. Centers and F. D. Price Jun. 1987 23 p
(AD-A183286; AFWAL-TR-87-2015) Avail: NTIS HC A02/MF A01 CSCL 11H

An in-line Complete Oil Breakdown Rate Analyzer (COBRA) and Quantitative Debris Monitor (QDMR) were installed in the oil system of an aircraft turbine engine lubricant simulator. The in-line COBRA readings correlated well with those of a standard laboratory model COBRA and total acid number of the deteriorating lubricant. Increases in QDMR particle counts corresponded with increases in trace iron content, which reflected abnormal wear occurring in the simulator. Analytical and direct reading ferrographic data confirmed the rapid increase and eventual modest decrease in wear debris concentration. After test completion, it was determined that a mainshaft bearing had experienced abnormal wear. Thus, for the first time successful capability for real-time simultaneous in-line wear and lubricant condition monitoring was demonstrated. GRA

**N87-29843#** Universal Energy Systems, Inc., Dayton, Ohio.

**MODIFICATION OF LUBRICANT TRACTION MEASURING DEVICE Final Report, Oct. 1983 - Jul. 1984**

Shashi K. Sharma 16 Jan. 1987 45 p
(Contract F33615-82-C-50001)
(AD-A183289; AFWAL-TR-86-4031) Avail: NTIS HC A03/MF A01 CSCL 11H

Lubricant Traction Measuring Device (Traction Rig) was designed and manufactured by Shaker Research Corporation. In the original design, the operation of the traction rig was primarily manual with provisions for automatic data logging but without anticipating. Later the traction rig operation was completely automated and computerized. Mechanical difficulties were also encountered during operation of the traction rig. The purpose of this document is to record the mechanical problems faced in operation of the traction rig from October 1983 to April 1984 and the modification carried out to solve them. Calibration of disc load versus the applied load is also reported. GRA

**N87-29844#** Carnegie-Mellon Univ., Pittsburgh, Pa. Robotics Inst.

**THE 1986 YEAR END REPORT FOR ROAD FOLLOWING AT CARNEGIE-MELLON Annual Report, 15 Jan. 1986 - 14 Jan. 1987**

Charles Thorpe and Takeo Kanade May 1987 66 p
(Contract DACA76-85-C-0003; ARPA Order 5351)
(AD-A183879; CMU-RI-TR-87-11; ETL-0464) Avail: NTIS HC A04/MF A01 CSCL 13I

This report describes progress in vision and navigation for outdoor mobile robots at the Carnegie Mellon Robotics Institute during 1986. This research was sponsored by DARPA as part of the Strategic Computing Initiative. Our work during 1986 culminated in two demonstration systems. The first system drives the Terregator, a desk-sized robot with six wheels, around the network of campus sidewalks. This system, named Sidewalk II, uses a video camera to follow sidewalks and a laser rangefinder to detect and avoid stairs. Sidewalk II makes extensive use of map data, for visual predictions and for path planning. The second system, Park Navigation, uses the Navlab, our new Chevrolet Van robot. The Park system concentrated on vision for following difficult roads, including curves, dirt and leaves, shadows, puddles, and both moving and fixed obstacles. We developed computer vision

techniques for handling difficult roads, and built range finder programs for detecting and avoiding obstacles. GRA

**N87-29845#** Dayton Univ., Ohio. Research Inst.
**LUBRICANT PERFORMANCE AND EVALUATION Interim Report, 17 Jun. 1985 - 17 Jan. 1987**
Costandy S. Saba, Hoover A. Smith, Michael A. Keller, Vinod K. Jain, and Robert E. Kauffman Jun. 1987 567 p
(Contract F33615-85-C-2507)
(AD-A183881; UDR-TR-87-24; AFWAL-TR-87-2025) Avail: NTIS HC A24/MF A01 CSCL 11H

Arrhenius plots were developed to describe the effective lives of six MIL-L-7808 lubricants as a function of temperature for selected limiting values of changes in total acid numbers, viscosities and weight losses. Relative ranking of lubricants with respect to their stability depends to some degree on defining maximum permissible limiting values. The static coker deposition tester was used to study the coking characteristics of lubricants. Ranking lubricants with respect to their deposit levels using the static coker was in general similar to the MCRT and coking propensity tests. Foaming characteristics of MIL-L-7808 lubricants were investigated using a static foaming test. Parameters studied included sample volume, airflow, ASTM stone and metal spargers. Foaming data shows the 25 ml volume test using the 13/16 inch diameter 5 micron rated pore size sparger correlates the best with the 200 ml volume Test Method 3213. Chromatographic methods developed for analysis of antioxidants in MIL-L-7808 resulted in isolation and identification of the major intermediates produced during oxidation of PANA and DODPA containing lubricants. GRA

**N87-29846*#** Chicago Univ., Ill.
**HELICAL GEARS WITH CIRCULAR ARC TEETH: GENERATION, GEOMETRY, PRECISION AND ADJUSTMENT TO ERRORS, COMPUTER AIDED SIMULATION OF CONDITIONS OF MESHING AND BEARING CONTACT Final Report**
Faydor L. Litvin and Chung-Biau Tsay Washington NASA Oct. 1987 95 p
(Grant NAG3-655)
(NASA-CR-4089; E-3541; NAS 1.26:4089) Avail: NTIS HC A05/MF A01 CSCL 13I

The authors have proposed a method for the generation of circular arc helical gears which is based on the application of standard equipment, worked out all aspects of the geometry of the gears, proposed methods for the computer aided simulation of conditions of meshing and bearing contact, investigated the influence of manufacturing and assembly errors, and proposed methods for the adjustment of gears to these errors. The results of computer aided solutions are illustrated with computer graphics. Author

**N87-29847** Clemson Univ., S.C.
**ANALYSIS AND CONTROL OF REDUNDANT ROBOTS Ph.D. Thesis**
Rajiv V. Dubey 1986 165 p
Avail: Univ. Microfilms Order No. DA8709144

Six coordinates, three for position and three for orientation, are required to fully specify a three dimensional object in space. Robots, which are used to manipulate three dimensional objects in space, usually have six degrees-of-freedom. However, a significant portion of the workspace of most six degrees-of-freedom industrial robots is occupied by singularity regions. Presence of obstacles in the workspace of robots also limits their movements. An infinite number of trajectories in the joint space can be used to achieve a desired end-effector trajectory for redundant robots. The selection of a joint trajectory may be used to improve a performance measure. Two performance measures, manipulator velocity ratio (MVR) and manipulator mechanical advantage (MMA) are defined. Three different control schemes for robots with redundant joints were developed. Feasibility and effectiveness of these control schemes are demonstrated through simulations with graphics for a planar three degree-of-freedom robot and a three dimensional seven degree-of-freedom robot. Dissert. Abstr.

**N87-29646#** Royal Aircraft Establishment, Farnborough (England). Materials and Structures Dept.
**DIFFUSION BONDING OF METALS**
P. G. Partridge *In* Advisory Group for Aerospace Research and Superplasticity Aug. 1987 23 p (For primary document see N87-29641 24-26)
Copyright Avail: NTIS HC A10/MF A01

**N87-29859*#** AEC-Able Engineering Co., Inc., Goleta, Calif.
**FOLDING, ARTICULATED, SQUARE TRUSS**
Robert M. Warden *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 1-17 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29860*#** Toshiba Corp., Kanagawa (Japan). Research and Development Center.
**THE DESIGN AND DEVELOPMENT OF A TWO-DIMENSIONAL ADAPTIVE TRUSS STRUCTURE**
Fumihiro Kuwao, Shoichi Motohashi, Makoto Yoshihara, Kenichi Takahara, and Michihiro Natori (Tokyo Univ., Japan ) *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 19-34 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29861*#** University Coll. of North Wales, Bangor.
**A MICROGRAVITY ISOLATION MOUNT**
D. I. Jones, A. R. Owens, R. G. Owen, G. Roberts, D. W. Wyn-Roberts, and A. A. Robinson (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands ) *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium (date) 35-54 (SEE N87-29858 24-39) May 1987 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29862*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**AKM CAPTURE DEVICE**
William D. Harwell *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 55-63 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29863*#** Aeritalia S.p.A., Turin (Italy). Space Systems Div.
**GRABBER ARM MECHANISM FOR THE ITALIAN RESEARCH INTERIM STAGE (IRIS)**
Edmondo Turci *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 65-80 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29868*#** Societe Europeenne de Propulsion, Vernon (France).
**EXPERIENCES OF CNES AND SEP ON SPACE MECHANISMS ROTATING AT LOW SPEED**
G. Atlas and G. Thomin (Centre National d'Etudes Spatiales, Toulouse, France ) *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 131-144 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29869*#** Sperry Space Systems, Durham, N.C.
**COMMON DRIVE UNIT**
R. C. Ellis, R. A. Fink, and E. A. Moore *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 145-163 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29870*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**A REACTIONLESS PRECISION POINTING ACTUATOR**

Peter Wiktor *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 165-174 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29871*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**THE DESIGN OF WORM GEAR SETS**
Andrea I. Razzaghi *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 175-193 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29872*#** Ball Aerospace Systems Div., Boulder, Colo.
**POINTED TELESCOPE SUBASSEMBLY FOR THE UARS HIGH RESOLUTION DOPPLER IMAGER**
Robert D. Renken *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 195-209 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29876*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**THE PRELOADABLE VECTOR SENSITIVE LATCH FOR ORBITAL DOCKING/BERTHING**
William R. Acres and John J. Kennedy *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 247-259 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29880*#** United Kingdom Atomic Energy Authority, Risley (England). European Space Tribology Lab.
**GIOTTO'S ANTENNA DE-SPIN MECHANISM: OTS LUBRICATION AND THERMAL VACUUM PERFORMANCE**
M. J. Todd and K. Parker *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 295-314 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29881*#** Ball Aerospace Systems Div., Boulder, Colo.
**ANATOMY OF A BEARING TORQUE PROBLEM**
Damon D. Phinney *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 315-328 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

**N87-29882*#** AEC-Able Engineering Co., Inc., Goleta, Calif.
**SPACE STATION ALPHA JOINT BEARING**
Michael R. Everman, P. Alan Jones, and Porter A. Spencer (Lockheed Missiles and Space Co., Sunnyvale, Calif.) *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 329-343 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

# 38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

**N87-29848#** Du Pont de Nemours (E. I.) and Co., Aiken, S.C. Savannah River Lab.
**ACOUSTIC EMISSION MONITORING OF PINCH WELDS**
K. E. Kain and R. R. Lawson May 1987 20 p
(Contract DE-AC09-76SR-00001)
(DE87-011245; DPST-87-437) Avail: NTIS HC A02/MF A01

Acoustic emission (AE) response during welding was examined as a possible nondestructive tool to evaluate weld quality. Welding was performed with varying current, gas atmosphere, stem restraint, and surface oxide thickness. The welds were examined for peel strength, fracture surface appearance, and metallurgical bond quality. Acoustic emission monitoring and analysis was performed by the Physical Acoustics Corporation (PAC). Results show that the AE welding function (AEWF) as defined by PAC is a good measure of bond strength for normal stems welded in a hydrogen atmosphere. The AEWF increases as the weld strength and bond quality increase. The AE analysis gave significant information regarding welding mechanisms. Plastic deformation, associated with a low AEWF, occurs at low currents and at the beginning of the weld period. At higher currents, recrystallization and grain growth occur across the bond interface, resulting in good strength and medium AEWF values. For fully restrained stems, melting and solidification processes are observed to greatly increase the bond strength and AE response. DOE

**N87-29849#** Brookhaven National Lab., Upton, N. Y.
**RESEARCH QUALITY: THE R AND D COMMUNITY RESPONDS QUALITY ASSURANCE FROM A RESEARCHER'S PERSPECTIVE**
R. Thomas 1987 7 p Presented at the 14th Annual National American Society for Quality Control, Las Vegas, Nev., 14 Sep. 1987
(Contract DE-AC02-76CH-00016)
(DE87-012478; BNL-39992; CONF-870950-2) Avail: NTIS HC A02/MF A01

Real basic scientific research principally is individual human expression, with no known proven techniques or procedures to achieve its purpose. For this reason present day quality assurance techniques are only applicable to the myriad of measurements, procedures, constructions, etc., which are carried out in support of basic scientific research, but which are themselves not basic scientific research. DOE

**N87-29850*#** Illinois Univ. at Urbana-Champaign, Savoy. Coordinated Science Lab.
**MEASUREMENT-BASED RELIABILITY/PERFORMABILITY MODELS**
Mei-Chen Hsueh Sep. 1987 112 p Sponsored in part by IBM
(Grant NAG1-613)
(NASA-CR-181299; NAS 1.26:181299; UILU-ENG-87-2258; CSG-71) Avail: NTIS HC A06/MF A01 CSCL 14D

Measurement-based models based on real error-data collected on a multiprocessor system are described. Model development from the raw error-data to the estimation of cumulative reward is also described. A workload/reliability model is developed based on low-level error and resource usage data collected on an IBM 3081 system during its normal operation in order to evaluate the resource usage/error/recovery process in a large mainframe system. Thus, both normal and erroneous behavior of the system are modeled. The results provide an understanding of the different types of errors and recovery processes. The measured data show that the holding times in key operational and error states are not simple exponentials and that a semi-Markov process is necessary to model the system behavior. A sensitivity analysis is performed to investigate the significance of using a semi-Markov process, as opposed to a Markov process, to model the measured system.
Author

**N87-29851#** Stanford Univ., Calif. Dept. of Statistics.
**ESTIMATING JOINTLY SYSTEM AND COMPONENT RELIABILITIES USING A MUTUAL CENSORSHIP APPROACH**
Hani Doss, Steven Freitag, and Frank Proschan 7 Jul. 1987 29 p
(Contract N00014-86-K-0156)
(AD-A183355; TR-393) Avail: NTIS HC A03/MF A01 CSCL 14D

Let F denote the life distribution of a coherent structure of independent components. Suppose that we have a sample of independent systems, all having the same structure. Each system is continuously observed until it fails. For every component in each system, either a failure time or a censoring time is recorded. A failure time is recorded if the component fails before or at the time of system failure; otherwise a censoring time is recorded. The authors introduce a method for finding estimates for F(t),

quantiles, and other functionals of F, based on the censorship of the component lives by system failure. The theory of counting processes and stochastic integrals is used to obtain limit theorems that enable the construction of confidence intervals for large samples. This approach extends and gives a novel application of censoring methodology. GRA

**N87-29852#** Naval Research Lab., Washington, D.C.
**DEFECTS, CONSTITUTIVE BEHAVIOR AND CONTINUUM TOUGHNESS CONSIDERATIONS FOR WELD INTEGRITY ANALYSIS**
Peter Matic and Mitchell I. Jolles 21 Jul. 1987 22 p
(AD-A183388; NRL-MR-5935) Avail: NTIS HC A02/MF A01
CSCL 13E

The failure load of a butt welded T-frame with a lack of fusion defect is predicted and compared with experimental data. Energy density concepts are used to quantitatively describe the material toughness at the continuum scale. Particular attention is given to the determination of base metal and weld metal uniaxial stress-strain curves valid for large deformation. Finite element results are used to predict the location where the energy density first reaches a critical value, and the corresponding applied load. The predicted initiation site and load compares favorably with the experiment. GRA

# 39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

**N87-29853** ESDU International Ltd., London (England).
**ELASTIC STRESS AND STRAIN DISTRIBUTIONS AROUND CIRCULAR HOLES IN INFINITE PLATES OF ORTHOTROPIC MATERIAL (APPLICABLE TO FIBRE REINFORCED COMPOSITES): COMPUTER PROGRAM**
Nov. 1985 28 p
(ESDU-85001; ISBN-0-85679-507-0; ISSN-0141-4097) Avail: ESDU

A FORTRAN program is presented that yields the stress and strain distribution around the circumference of a hole in an orthotropic sheet under any combination of in-plane direct and shear loading. The output includes the stresses and strains in the orthogonal directions of the plate axes, and stresses and strains acting circumferentially and normal to the circumference of the hole. Input to the program may be one of: the equivalent elastic properties of the complete laminate, the equivalent elastic properties of each individual layer, or the in-plane stiffness terms of the stiffness matrix for the complete laminate. Guidance is given on interpretation of the results when used to assess in-plane failure of laminated composites. The data should be applied to large holes in thin laminates where the diameter is greater than five times the thickness, and are satisfactory when the edge of the hole is at least 1.5 hole diameters away from the laminate edge or other feature. ESDU

**N87-29854** ESDU International Ltd., London (England).
**FATIGUE STRENGTH OF STEEL STUD THREADS UNDER AXIAL AND COMBINED AXIAL AND BENDING LOADINGS**
Mar. 1985 17 p
(ESDU-85004; ISBN-0-85679-510-0; ISSN-0143-4089) Avail: ESDU

This Data Item #85004, an addition to the Stress and Strength Sub-series, gives stress-endurance curves through the results extracted from the literature of some 80 constant amplitude fatigue tests on five different types of studs with machined threads torque-tightened into a steel block. The studs failed at the first loaded thread in the block; for fatigue failures in the thread of the nut, see ESDU 84037. The relative merits of the five designs are compared. In particular, the provision of a proper seating allows the initial tightening torque to give a beneficial pre-tension that relieves the load subsequently applied to the stud thread by the assembly of a component on it. A discussion of the load paths through an assembly is included since detail design affects that and hence the fatigue strength. A worked example illustrates how such an analysis is used to establish the fatigue strength of a stud in a practical situation. ESDU

**N87-29855** ESDU International Ltd., London (England).
**CONTACT PHONEMENA. PART 3: CALCULATION OF INDIVIDUAL STRESS COMPONENTS IN CONCENTRATED ELASTIC CONTACTS UNDER COMBINED NORMAL AND TANGENTIAL LOADING**
May 1985 69 p
(ESDU-85007; ISBN-0-85679-513-7; ISSN-0141-2590; ISSN-0141-4046) Avail: ESDU

A step by step calculation procedure and a FORTRAN program are presented for the evaluation of the individual stress components associated with the contact region of two unlubricated elastic bodies subjected to normal and tangential loading. The procedure covers elliptical, circular or line (rectangular) contact areas. Special cases that arise where the solutions may become indeterminate, or can be simplified, are treated separately. The method also assumes that the maximum compressive stress and lengths of the axes of the contact ellipse are known; values for those quantities may be found using part 1 of ESDU 78035, which deals with stresses due to contact under normal load alone. Although the stresses found apply strictly to unlubricated contact, they do represent the worst case, and in fact are also valid for boundary lubrication and are approximately correct for very thin films in elastohydrodynamic lubrication, that is, at low surface velocities and low lubricant viscosities. Part 2 of ESDU 84017 presents graphically the results of some of these calculations but only for a limited range of values of the variables such as friction coefficient, Poisson's ratio, axis ratio of the contact ellipse, etc. ESDU

**N87-29856#** Lawrence Livermore National Lab., Calif.
**FEA PREDICTIONS OF RESIDUAL STRESS IN STAINLESS STEEL COMPARED TO NEUTRON AND X-RAY DIFFRACTION MEASUREMENTS**
E. C. Flower, S. R. MacEwen, and T. M. Holden May 1987 13 p Presented at the 2nd International Conference on Advances in Numerical Methods in Engineering: Theory and Application, Swansea, England, 6 Jul. 1987 Prepared in cooperation with Atomic Energy of Canada Ltd., Chalk River, Ontario
(Contract W-7405-eng-48)
(DE87-011562; UCRL-96643; CONF-870772-1) Avail: NTIS HC A02/MF A01

Residual stresses in a body arise from nonuniform plastic deformation and continue to be an important consideration in the design and the fabrication of metal components. The finite element method offers a potentially powerful tool for predicting these stresses. However, it is important to first verify this method through careful analysis and experimentation. This paper describes experiments using neutron and X-ray diffraction to provide quantitative data to compare to finite element analysis predictions of deformation induced residual stress in a plane stress austenitic stainless steel ring. Good agreement was found between the experimental results and the numerical predictions. Effects of the formulation of the finite element model on the analysis, constitutive parameters and effects of machining damage in the experiments are addressed. DOE

**N87-29857#** Los Alamos National Lab., N. Mex.
**HIGH-STRAIN-RATE DEFORMATION MECHANISMS IN COPPER AND IMPLICATIONS FOR BEHAVIOR DURING SHOCK-WAVE DEFORMATION**
P. S. Follansbee 1987 19 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract W-7405-eng-36)
(DE87-011733; LA-UR-87-2198; CONF-870753-14) Avail: NTIS HC A02/MF A01

A recently developed model for the deformation of copper is reviewed. The model separates the kinetics of structure evolution from those at constant structure and uses the mechanical threshold stress (yield stress at 0 K) as an internal-state variable. Predictions of the stress-strain behavior at high strain rates are compared with experimental results, and the potential application of the modeling procedure in the shock-wave regime is discussed.
DOE

**N87-29858*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**THE 21ST AEROSPACE MECHANISMS SYMPOSIUM**
May 1987 356 p Symposium held in Houston, Tex., 29 Apr. - 1 May 1987; sponsored by NASA, California Inst. of Tech., and LMSC
(NASA-CP-2470; S-560; NAS 1.55:2470) Avail: NTIS HC A16/MF A01 CSCL 20K

During the symposium technical topics addressed included deployable structures, electromagnetic devices, tribology, actuators, latching devices, positioning mechanisms, robotic manipulators, and automated mechanisms synthesis. A summary of the 20th Aerospace Mechanisms Symposium panel discussions is included as an appendix. However, panel discussions on robotics for space and large space structures which were held are not presented herein. For individual titles, see N87-29859 through N87-29882.

**N87-29859*#** AEC-Able Engineering Co., Inc., Goleta, Calif.
**FOLDING, ARTICULATED, SQUARE TRUSS** **c37**
Robert M. Warden *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 1-17 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

A larger, stronger deployable boom was developed to handle the requirements of larger, heavier payloads in space. The main components of the boom and its deployer are described and their functions explained. Desirable features of the boom are identified and physical properties are reported. Author

**N87-29860*#** Toshiba Corp., Kanagawa (Japan). Research and Development Center.
**THE DESIGN AND DEVELOPMENT OF A TWO-DIMENSIONAL ADAPTIVE TRUSS STRUCTURE** **c37**
Fumihiro Kuwao, Shoichi Motohashi, Makoto Yoshihara, Kenichi Takahara, and Michihiro Natori (Tokyo Univ., Japan ) *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 19-34 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

The functional model of a two dimensional adaptive truss structure which can purposefully change its geometrical configuration is introduced. The details of design and fabrication such as kinematic analysis, dynamic characteristics analysis and some test results are presented for the demonstration of this two dimensional truss concept. Author

**N87-29861*#** University Coll. of North Wales, Bangor.
**A MICROGRAVITY ISOLATION MOUNT** **c37**
D. I. Jones, A. R. Owens, R. G. Owen, G. Roberts, D. W. Wyn-Roberts, and A. A. Robinson (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands ) *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium (date) 35-54 (SEE N87-29858 24-39) May 1987 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

The design and preliminary testing of a system for isolating microgravity sensitive payloads from spacecraft vibrational and impulsive disturbances is discussed. The Microgravity Isolation Mount (MGIM) concept consists of a platform which floats almost freely within a limited volume inside the spacecraft, but which is constrained to follow the spacecraft in the long term by means of very weak springs. The springs are realized magnetically and form part of a six degree of freedom active magnetic suspension system. The latter operates without any physical contact between the spacecraft and the platform itself. Power and data transfer is also performed by contactless means. Specifications are given for the expected level of input disturbances and the tolerable level of platform acceleration. The structural configuration of the mount is discussed and the design of the principal elements, i.e., actuators, sensors, control loops and power/data transfer devices are described. Finally, the construction of a hardware model that is being used to verify the predicted performance of the MGIM is described. Author

**N87-29862*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**AKM CAPTURE DEVICE** **c37**
William D. Harwell *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 55-63 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

In an effort to recover the Westar and Palapa satellites and the considerable investment each represented, NASA and Hughes undertook the Satellite Retrieval Mission. The mechanism used to capture each of the errant satellites was the AKM (Apogee Kick Motor) Capture Device (ACD), also referred to as the Stinger. The ACD had three interface requirements: interface with the Manned Maneuvering Unit (MMU) for transportation to and stabilization of the spacecrafts; interface with each satellite for retrieval; and finally, interface with the Shuttle's Remote Manipulator System (RMS or robot arm) for satellite transport back to the Orbiter's payload bay. The majority of the design requirements were associated with the capture and release of the satellites. In addition to these unique requirements, the general EVA, RMS grapple, and RMS manipulation requirements applied. These requirements included thermal, glare, snag, RMS runaway and crewman safety considerations. E.R.

**N87-29863*#** Aeritalia S.p.A., Turin (Italy). Space Systems Div.
**GRABBER ARM MECHANISM FOR THE ITALIAN RESEARCH INTERIM STAGE (IRIS)** **c37**
Edmondo Turci *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 65-80 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

Two deployable arms, named grabbers, were designed and manufactured to provide lateral stability of the perigee spinning stage which will be deployed from the Space Shuttle cargo bay. The spinning stage is supported by a spin table on a cradle at its base. The Italian Research Interim Stage (IRIS) is designed to carry satellites of intermediate mass up to 900 kg. The requirements are defined and the mechanism is described. Functional test results are presented. Author

**N87-29864*#** RCA Aerospace and Defense, East Windsor, N.J. Astro-Space Div.
**DEVELOPMENT OF A STANDARD CONNECTOR FOR ORBITAL REPLACEMENT UNITS FOR SERVICEABLE SPACECRAFT** **c18**
Ellen F. Heath, Matthew A. Braccio, Steven D. Raymus, and David W. Gross *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 81-92 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 22B

The current trend for spacecraft to be serviceable and repairable in orbit has led to a modular approach to satellite subsystem design. Spacecraft equipment, such as sensors, tape recorders, computers, transponders, batteries, etc., housed in discrete modular units, (Orbital Replacement Units(ORUs)) can be attached and detached to the spacecraft as needed. The interface between the ORU and the spacecraft is crucial. The projected use of robotics and the need for a common mechanism capable of performing several functions puts many constraints on the design of the interface. Such an interface mechanisms was designed and developed called the Standard Interface Connector (SIC) that mates the ORU to the spacecraft. The SIC also provides for the flow of

fluids, data, and power between the module and spacecraft. The baseline design presented can be configured to provide various attachment schemes. Tests on SIC models have demonstrated the functionality of the design and its compatibility with current robotics. Author

**N87-29865*#** Rockwell International Corp., Downey, Calif. Space Station Systems Div.
**THE DESIGN AND DEVELOPMENT OF A MOBILE TRANSPORTER SYSTEM FOR THE SPACE STATION REMOTE MANIPULATOR SYSTEM** **c54**
Thomas W. Carroll *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 93-101 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 05H

The analyses, selection process, and conceptual design of potential candidate Mobile Transporter (MT) systems to move the Space Station Remote Manipulator System (SSRMS) about the exposed faces of the Space Station truss structure are described. The actual requirements for a manipulator system on the space station are discussed, including potential tasks to be performed. The SSRMS operating environment and control methods are analyzed with potential design solutions highlighted. Three general categories of transporter systems are identified and analyzed. Several design solution have emerged that will satisfy these requirements. Their relative merits are discussed, and unique variations in each system are rated for functionality. Author

**N87-29866*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**TELEROBOTIC WORK SYSTEM: CONCEPT DEVELOPMENT AND EVOLUTION** **c54**
Lyle M. Jenkins *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 103-110 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 05H

The basic concept of a telerobotic work system (TWS) consists of two dexterous manipulator arms controlled from a remote station. The term telerobotic describes a system that is a combination of teleoperator control and robotic operation. Work represents the function of producing physical changes. System describes the integration of components and subsystems to effectively accomplish the needed mission. Telerobotics reduces exposure to hazards for flight crewmembers and increases their productivity. The requirements for the TWS are derived from both the mission needs and the functional capabilities of existing hardware and software to meet those needs. The development of the TWS is discussed. Author

**N87-29867*#** Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn.
**TRACTION-DRIVE, SEVEN-DEGREE-OF-FREEDOM TELEROBOT ARM: A CONCEPT FOR MANIPULATION IN SPACE** **c54**
D. P. Kuban and D. M. Williams *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 111-130 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 05H

As man seeks to expand his dominion into new environments, the demand increases for machines that perform useful functions in remote locations. This new concept for manipulation in space is based on knowledge and experience gained from manipulator systems developed to meet the needs of remote nuclear applications. It merges the best characteristics of teleoperation and robotic technologies. The design goals for the telerobot, a mechanical description, and technology areas that must be addressed for successful implementation are presented and discussed. The concept incorporates mechanical traction drives, redundant kinematics, and modular arm subelements to provide a backlash-free manipulator capable of obstacle avoidance. Author

**N87-29868*#** Societe Europeenne de Propulsion, Vernon (France).
**EXPERIENCES OF CNES AND SEP ON SPACE MECHANISMS ROTATING AT LOW SPEED** **c37**
G. Atlas and G. Thomin (Centre National d'Etudes Spatiales, Toulouse, France ) *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 131-144 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

Some aspects of knowledge acquired in the field of space mechanisms by Societe Europeenne de Propulsion and Centre National d'Etudes Spatiales in International and French National space programs are described. The experience described centers on the development of these programs: The MEGS (Mechanisme d'Etrainement du Generateur Solaire), and the MOGS (Mechanisme d'Orientation de Generateur Solaire), both solar array drive mechanisms. Key design areas and the mechanism performance obtained are highlighted. Some test problems with the MEGS sliprings are discussed. Author

**N87-29869*#** Sperry Space Systems, Durham, N.C.
**COMMON DRIVE UNIT** **c37**
R. C. Ellis, R. A. Fink, and E. A. Moore *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 145-163 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

The Common Drive Unit (CDU) is a high reliability rotary actuator with many versatile applications in mechanism designs. The CDU incorporates a set of redundant motor-brake assemblies driving a single output shaft through differential. Tachometers provide speed information in the AC version. Operation of both motors, as compared to the operation of one motor, will yield the same output torque with twice the output speed. Author

**N87-29870*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**A REACTIONLESS PRECISION POINTING ACTUATOR** **c37**
Peter Wiktor *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 165-174 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

The applications, design, control and testing of an actuator that provides the precise motion control of a gimbal platform without torquing against the basebody to which it is attached are described. The reactionless actuator described was given the name reactuator. Author

**N87-29871*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**THE DESIGN OF WORM GEAR SETS** **c37**
Andrea I. Razzaghi *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 175-193 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

A method is presented for designing worm gear sets to meet torque multiplication requirements. First, the fundamentals of worm gear design are discussed, covering worm gear set nomenclature, kinematics and proportions, force analysis, and stress analysis. Then, a suggested design method is discussed, explaining how to take a worm gear set application, and specify a complete worm gear set design. The discussions are limited to cylindrical worm gear sets that have a 90 deg shaft angle between the worm and the mating gear. Author

**N87-29872*#** Ball Aerospace Systems Div., Boulder, Colo.
**POINTED TELESCOPE SUBASSEMBLY FOR THE UARS HIGH RESOLUTION DOPPLER IMAGER** **c37**
Robert D. Renken *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 195-209 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

The Pointed Telescope Subassembly (PTS) consists of a telescope, its Coude relay optics, a two axis gimbal mechanism, and a cover/caging device. These components, their mechanisms, the requirements, and some of the trade-offs leading to the final design are described. The PTS supplies light to the interferometer of the High Resolution Doppler Imager to be used to study upper atmospheric wind velocity. Author

**N87-29873*#** Lockheed Missiles and Space Co., Sunnyvale, Calif.

**PASSIVE ISOLATION/DAMPING SYSTEM FOR THE HUBBLE SPACE TELESCOPE REACTION WHEELS**

Martin D. Hasha *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 211-226 (For primary document see N87-29858 24-39)

Avail: NTIS HC A16/MF A01 CSCL 20K

NASA's Hubble Space Telescope contain large, diffraction limited optics with extraordinary resolution and performance for surpassing existing observatories. The need to reduce structural borne vibration and resultant optical jitter from critical Pointing Control System components, Reaction Wheels, prompted the feasibility investigation and eventual development of a passive isolation system. Alternative design concepts considered were required to meet a host of stringent specifications and pass rigid tests to be successfully verified and integrated into the already built flight vehicle. The final design employs multiple arrays of fluid damped springs that attenuate over a wide spectrum, while confining newly introduced resonances to benign regions of vehicle dynamic response. Overall jitter improvement of roughly a factor of 2 to 3 is attained with this system. The basis, evolution, and performance of the isolation system, specifically discussing design concepts considered, optimization studies, development lessons learned, innovative features, and analytical and ground test verified results are presented. Author

**N87-29874*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**A MULTIPURPOSE SATELLITE EJECTION SYSTEM c18**

Michael B. Moore *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 227-234 (For primary document see N87-29858 24-39)

Avail: NTIS HC A16/MF A01 CSCL 22B

A design is presented for a pneumatic ejection system capable of ejecting a spin stabilized satellite from the cargo bay of space vehicles. This system was orginally designed for use on the Spacelab 6 shuttle mission, but is now being considered for use with expendable rockets for launching satellites. The ejection system was designed to launch a 150 lb satellite at an initial ejection velocity of 32 ft/sec with a spin rate of 30 rev/min. The ejection system consists of a pneumatic cylinder, satellite retaining mechanism, and bearing assembly to allow the satellite to rotate during the spin up phase. As the cylinder is pressurized rapidly causing movement of the actuation piston, the mechanism automatically releases the spinning satellite by retracting a pneumatic locking pin and three spring loaded holddown pins. When the piston reaches the end of its stroke, it encounters a crushable aluminum honeycomb shock absorber which decelerates the piston and retaining mechanism. The assembly is designed for multiple uses except for the crushable shock absorber and pyrotechnic valves. The advantage of the design is discussed and patent no. and date given. Author

**N87-29875*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

**A CAD/CAE ANALYSIS OF PHOTOGRAPHIC AND ENGINEERING DATA c35**

S. Michael Goza and Wayne L. Peterson *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 235-246 (For primary document see N87-29858 24-39)

Avail: NTIS HC A16/MF A01 CSCL 14E

In the investigation of the STS 51L accident, NASA engineers were given the task of visual analysis of photographic data extracted from the tracking cameras located at the launch pad. An analysis of the rotations associated with the right Solid Rocket Booster (SRB) was also performed. The visual analysis involved pinpointing coordinates of specific areas on the photographs. The objective of the analysis on the right SRB was to duplicate the rotations provided by the SRB rate gyros and to determine the effects of the rotations on the launch configuration. To accomplish the objectives, computer aided design and engineering was employed. The solid modeler, GEOMOD, inside the Structural Dynamics Research Corp. I-DEAS package, proved invaluable. The problem areas that were encountered and the corresponding solutions that were obtained are discussed. A brief description detailing the construction of the computer generated solid model of the STS launch configuration is given. A discussion of the coordinate systems used in the analysis is provided for the purpose of positioning the model in coordinate space. The techniques and theory used in the model analysis are described. Author

**N87-29876*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

**THE PRELOADABLE VECTOR SENSITIVE LATCH FOR ORBITAL DOCKING/BERTHING c37**

William R. Acres and John J. Kennedy *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 247-259 (For primary document see N87-29858 24-39)

Avail: NTIS HC A16/MF A01 CSCL 13I

The workings and function of the Preloader Vector Sensitive Latch are described. A discussion of docking systems used in the U.S. manned space flight programs is included to show how docking systems have evolved, and to highlight the potential advantages of a preloadable vector sensitive latch in such systems. Author

**N87-29877*#** Rockwell International Corp., Downey, Calif. Space Station Systems Div.

**SPACE STATION BASED OPTIONS FOR ORBITER DOCKING/BERTHING c18**

Daniel J. Hoover *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 261-273 (For primary document see N87-29858 24-39)

Avail: NTIS HC A16/MF A01 CSCL 22B

Conceptual efforts to develop a Space Station based system for docking and/or berthing the NSTS Orbiter are described. Past docking and berthing systems are reviewed, the general requirements and options for mating the Orbiter and Space Station are discussed, and the rationale for locating the system on the Station is established. One class of Station-based system is developed in several variations and evaluated with respect to weight distribution, loads, safety, reliability, viewing, and maintainability. An evolutionary presentation of the variations provides insight into the development process and the problems encountered. An overall evaluation of the Station-based variations compared to an optimized Orbiter-based system demonstrates the potential benefits of this approach as well as the issues that must be resolved to realize the benefits. Author

**N87-29878*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

**AN ELECTROMECHANICAL ATTENUATOR/ACTUATOR FOR SPACE STATION DOCKING c18**

LeBarian Stokes, Dean Glenn, and Monty B. Carroll (Lockheed Engineering and Management Services Co., Inc., Houston, Tex.) *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 275-284 (For primary document see N87-29858 24-39)

Avail: NTIS HC A16/MF A01 CSCL 22B

The development of a docking system for aerospace vehicles has identified the need for reusable and variably controlled attenuators/actuators for energy absorption and compliance. One approach to providing both the attenuator and the actuator functions is by way of an electromechanical attenuator/actuator (EMAA) as opposed to a hydraulic system. The use of the electromechanical devices is considered to be more suitable for a space environment because of the absence of contamination from hydraulic fluid leaks and because of the cost effectiveness of maintenance. A smart EMAA that uses range/rate/attitude sensor

information to preadjust a docking interface to eliminate misalignments and to minimize contact and stroking forces is described. A prototype EMAA was fabricated and is being tested and evaluated. Results of preliminary testing and analysis already performed have established confidence that this concept is feasible and will provide the desired reliability and low maintenance for repetitive long term operation typical of Space Station requirements. Author

**N87-29879*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**SPACE STATION LUBRICATION CONSIDERATIONS c18**
Lubert J. Leger and Keith Dufrane (Battelle Columbus Labs., Ohio.) *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 285-294 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 22B

Future activities in space will require the use of large structures and high power availability in order to fully exploit opportunities in Earth and stellar observations, space manufacturing and the development of optimum space transportation vehicles. Although these large systems will have increased capabilities, the associated development costs will be high, and will dictate long life with minimum maintenance. The Space Station provides a concrete example of such a system; it is approximately one hundred meters in major dimensions and has a life requirement of thirty years. Numerous mechanical components will be associated with these systems, a portion of which will be exposed to the space environment. If the long life and low maintenance goals are to be satisfied, lubricants and lubrication concepts will have to be carefully selected. Current lubrication practices are reviewed with the intent of determining acceptability for the long life requirements. The effects of exposure of lubricants and lubricant binders to the space environment are generally discussed. Potential interaction of MoS2 with atomic oxygen, a component of the low Earth orbit environment, appears to be significant. Author

**N87-29880*#** United Kingdom Atomic Energy Authority, Risley (England). European Space Tribology Lab.
**GIOTTO'S ANTENNA DE-SPIN MECHANISM: OTS LUBRICATION AND THERMAL VACUUM PERFORMANCE c37**
M. J. Todd and K. Parker *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 295-314 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

Except in the near Earth phase of GIOTTO's mission to Comet Halley, the HGA (high gain antenna) on board GIOTTO was the only designed means of up/down communications. The spacecraft spin stabilization required that the HGA be despun at the same rotational rate of nominally 15 rpm in order to keep the HGA pointing accurately to a Earth. A dual servomotor despin mechanism was designed and built by SEP of France for this purpose. The expected thermal environment suggested that dry lubrication was preferable to wet for the ball bearings but there existed no relevant data on the torque noise spectrum of candidate solid lubricants. Therefore ad hoc torque noise tests were run with two solid lubricants: ion plated lead film plus lead bronze cage (retainer) and a PTFE composite cage only. The lead lubrication showed the better spectrum up to the mission lifetime point so it was selected for continued test over some 20 times the Halley mission life, with periodic torque spectrum monitoring. The spectrum remained well within the pointing error budget over the 100 million revolutions covered. Author

**N87-29881*#** Ball Aerospace Systems Div., Boulder, Colo.
**ANATOMY OF A BEARING TORQUE PROBLEM c37**
Damon D. Phinney *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 315-328 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

In the early 1970s, an antenna despin drive was developed for MBB solar science satellite HELIOS. A problem with high bearing drag torque that was encountered on the two flight models of this drive, after successful tests were completed on twelve bearings, an engineering model, and the qualification unit is discussed. Author

**N87-29882*#** AEC-Able Engineering Co., Inc., Goleta, Calif.
**SPACE STATION ALPHA JOINT BEARING c37**
Michael R. Everman, P. Alan Jones, and Porter A. Spencer (Lockheed Missiles and Space Co., Sunnyvale, Calif.) *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 329-343 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 13I

Perhaps the most critical structural system aboard the Space Station is the Solar Alpha Rotary Joint which helps align the power generation system with the sun. The joint must provide structural support and controlled rotation to the outboard transverse booms as well as power and data transfer across the joint. The Solar Alpha Rotary Joint is composed of two transition sections and an integral, large diameter bearing. Alpha joint bearing design presents a particularly interesting problem because of its large size and need for high reliability, stiffness, and on orbit maintability. The discrete roller bearing developed is a novel refinement to cam follower technology. It offers thermal compensation and ease of on-orbit maintenance that are not found in conventional rolling element bearings. How the bearing design evolved is summarized. Driving requirements are reviewed, alternative concepts assessed, and the selected design is described. Author

**N87-29883*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**NONLINEAR SHELL ANALYSES OF THE SRB/ETA RING INTERFACE**
Norman F. Knight, Jr. Jul. 1987 62 p
(NASA-TM-89164; NAS 1.15:89164) Avail: NTIS HC A04/MF A01 CSCL 20K

Two-dimensional shell models of the portion of the solid rocket booster (SRB) with the external tank attachment (ETA) ring were developed using the STAGSC-1 computer code. These analyses were performed in support of the SRB recertification program underway at the NASA Marshall Space Flight Center. The purpose of these analyses is to calculate the overall stress and deflection distributions for the SRB/ETA ring interface. An overview of the SRB/ETA ring geometry is presented followed by a discussion of the analysis methods and finite element models. Finally, the nonlinear structural response of the SRB/ETA ring interface is discussed. Author

**N87-29884#** Lawrence Livermore National Lab., Calif.
**MICROCRACK DEPENDENT DISCONTINUITY CONDITIONS ACROSS A SHOCK FRONT**
R. B. Stout Jun. 1987 11 p Presented at the 5th Topical Conference of the American Physical Society on Shockwaves in Condensed Matter, Monterey, Calif., 20 Jul. 1987
(Contract W-7405-eng-48)
(DE87-011888; UCRL-96386; CONF-870753-5) Avail: NTIS HC A02/MF A01

A shock front analysis for propagating spatial discontinuities of microcrack density, mass density, momentum density, and energy density is developed. The analysis is based on concepts from discontinuum mechanics, which in the case of microcrack kinetics represents interatomic discontinuities between the surfaces of a microcrack by a relative deformation functional. The kinematics of the relative deformation functional decomposes the total relative velocity between atoms into two forms; one is a relative velocity function to describe the recoverable lattice structure motion, and the other is a relative velocity functional to describe the motion from discontinuities due to microcrack kinetics. This means that across a shock front involving microcrack kinetics, the discontinuity conditions for mass density, momentum density, and energy density will depend explicitly on the microcrack density function. DOE

**N87-29885#** Oak Ridge Gaseous Diffusion Plant, Tenn. Enrichment Technology Applications Center.
**COMPRESSION FAILURE OF GRAPHITE/EPOXY RINGS UNDER STRAIN CONTROL LOADING**
H. W. Blake Jun. 1987 8 p Presented at the Joint Symposium on Composite Materials Science and Engineering, Newark, Del., 23 Sep. 1987
(Contract DE-AC05-84OT-21400)
(DE87-012036; K/ETAC-5; CONF-8709112-1) Avail: NTIS HC A02/MF A01

Composite rings of several graphite/epoxy materials were subjected to external pressure in a test fixture designed to provide strain control. The fixture suppresses the structural buckling modes of failure of the ring thus permitting thinner rings to be tested to their material strength limit without instability. Several failure modes are identified, and results for two materials are compared with tests on the same materials using flat specimens. DOE

**N87-29886#** Kernforschungsanlage, Juelich (West Germany). Inst. fuer Nukleare Sicherheitsforschung.
**THE CALCULATION OF CREEP DEFORMATIONS AND STRESSES IN THICK-WALLED TUBES [ZUR BERECHNUNG VON KRIECHVERFORMUNG UND SPANNUNGEN IN DICKWANDIGEN ROHREN]**
Gerd Breitbach, Steffi Kragl, Manfred Roedig, and Heinz-Josef Penkalla Sep. 1986 61 p In GERMAN
(JUEL-Spez-373; ISSN-0343-7639; ETN-87-90338) Avail: NTIS HC A04/MF A01

Methods for the calculation of stresses and creep deformations in thick-walled tubes under compressive and additional axial loads were developed for heat exchangers for methane reforming processes in helium cooled high temperature reactors where temperatures up to 800 to 950 C occur. At these temperatures creep processes play an important role in metal structures. The constitutive equation used is a Norton creep law. The deformation state without elongation in axial direction, and the thick-walled tube under purely axial compressive load were treated. Examples of an exact, continuum mechanical, numerical investigation on thick-walled tubes under internal pressure and axial tension are given. An approximation method for the calculation of stresses and creep deformations was derived. The results of calculations using the exact and the approximative method are compared and discussed. ESA

**N87-29887#** Kernforschungsanlage, Juelich (West Germany). Inst. fuer Reaktorwerkstoffe.
**TIME-INDEPENDENT PLASTICITY AS A LIMITING CASE OF CREEP**
H. Cords, G. Kleist, and R. Zimmermann Nov. 1986 44 p
(Juel-Spez-379; ISSN-0343-7639; ETN-87-90339) Avail: NTIS HC A03/MF A01

The unified theoretical description of the viscoplastic constitutive equations as used for metals or metal alloys, was developed. Concepts concerning the definition of the internal stress, plastic flow, and material hardening were introduced, mathematically formulated, and tested in comparison with a standard type of materials behavior. A system of simultaneous differential equations was defined and used to study materials effects observed in creep and plasticity, i.e., normal and inverted primary creep, recoverable creep, incubation time and anelasticity in stress reduction, negative stress relaxation, plastic flow, perfect plasticity, negative strain rate sensitivity, serrated flow, and strain hardening in monotonic and cyclic loading. The theoretical approach is based on a lateral contraction movement following the axial extension in a process of drag, which allows retardation and simultaneously impedes longitudinal strain. ESA

**N87-29888#** Kernforschungsanlage, Juelich (West Germany). Inst. fuer Reaktorwerkstoffe.
**CREEP RUPTURE BEHAVIOR OF WELDED JOINTS OF NI-BASED ALLOYS WITH SPECIAL REGARD TO THE LOCAL DEFORMATION BEHAVIOR Ph.D Thesis - Technische Hochschule**
Michael Kaffka, Philip James Ennis, Hans Schuster, and Hubertus Nickel Oct. 1986 186 p In GERMAN; ENGLISH summary
(JUEL-2092; ISSN-0366-0885; ETN-87-90342) Avail: NTIS HC A09/MF A01

The time-fatigue behavior of welds of an Mi alloy were investigated with the solid-solution strengthened wrought alloy MiCr22CoMo as test material. It is shown that information concerning the creep behavior of the individual zones of the welded joints is not sufficient for the determination of the integral strain of the weld. Creep strain constraints at the weld-parent metal transition can significantly affect the creep behavior of the weld. For a simple transition structure, finite element calculations were performed, and the observed behavior was theoretically reproduced. The decisive parameter for the integral creep strain of a weld is the volume fraction of welding metal in the gage length of the specimen. From the relationship between welding metal volume fraction and integral creep strain, a method which allows the determination of the strain distribution in a weld was developed. ESA

**N87-29889#** Bristol Univ. (England).
**A UNIFIED APPROACH TO THE IDENTIFICATION OF DYNAMIC BEHAVIOUR USING THE THEORY OF VECTOR SPACES Ph.D. Thesis**
Timothy Albert Brown Aug. 1985 307 p Sponsored by UK Science and Engineering Research Council
(ETN-87-90707) Avail: NTIS HC A14/MF A01

The finite element method and modal analysis are compared. Attempts to reconcile the differences in dynamic performance predicted by these methods are reviewed and the problem is rethought in the context of vector space theory. The analysis is built up in stages, commencing with a simple (3x3) matrix example. The introduction of vector space theory permits a reassessment of the techniques mentioned in order to unify the entire process of identification, and allowing it to be extended to the case of viscous damping. A simple beam is used to illustrate the analysis. ESA

**N87-29890#** California Univ., Berkeley. Dept. of Materials Science and Mineral Engineering.
**FATIGUE BEHAVIOR OF LONG AND SHORT CRACKS IN ALUMINUM ALLOYS Final Report, 15 Apr. 1984 - 14 Apr. 1987**
Robert O. Ritchie and Weikang Yu 1 May 1987 198 p
(Grant AF-AFOSR-0181-82)
(AD-A182949; UCB/RP/87/A1047; AFOSR-87-0872TR) Avail: NTIS HC A09/MF A01 CSCL 11F

The fatigue behavior of short cracks, which are small compared to the scale of the microstructure, small compared to the scale of local plasticity or simply physically small (i.e., 1 mm), must be considered one of the major factors limiting the application of defect-tolerant fatigue design for airframe and engine components. Accordingly, this program was aimed at identifying factors which govern the growth of such short cracks (in contrast to long cracks) in a series of commercial aluminum alloys, with specific reference to behavior at near threshold levels. Based on experiments in 2124, 7150 and 2090 alloys, it is shown that whereas the behavior of long cracks at near threshold levels is largely controlled by the magnitude of the crack tip shielding from crack closure and deflection mechanisms, short crack growth rates are invariably faster because of their inability to develop shielding due to their limited wake. Experiments whereby the wake material is physically removed confirm such notions and indicate that the predominant closure forces are located close (within 500 microns) of the tip. GRA

**N87-29891#** Purdue Univ., West Lafayette, Ind. School of Aeronautics and Astronautics.
**SYMMETRICALLY LAMINATED BEAM AND PLATE FINITE ELEMENTS WITH SHEAR DEFORMATION Final Report, Jun. 1983 - Oct. 1986**
T. Y. Yang and Alex T. Chen Apr. 1987 91 p
(Contract F33615-83-C-5076)
(AD-A182968; AFWAL-TR-87-4003) Avail: NTIS HC A05/MF A01 CSCL 11D

(AD-A182968; AFWAL-TR-87-4003) Avail: NTIS HC A05/MF A01 CSCL 11D

In this report, finite element formulations were developed for symmetrically laminated composite beams and plates for static and free vibration analyses. First, a formulation, an efficient solution procedure, a microcomputer program, and a graphics routine for a 12 d.o.f. anisotropic symmetrically laminated beam finite element including the effect of shear deformation are introduced. The emphasis of the formulation and solution procedure is for simplicity, efficiency, and easy implementation on microcomputers. The formulation, solution procedure, and the program have been evaluated by performing a systematic choice of examples; wherever possible, the present solutions are compared with alternative existing solutions. Second, an 18 d.o.f. triangular plate element in bending with anisotropic symmetrically laminated composite materials is formulated. GRA

**N87-29892#** Northwestern Univ., Evanston, Ill. Dept. of Materials Science.

**THE USE OF X-RAYS AND NEUTRONS TO MEASURE (RESIDUAL) STRESS ELASTIC CONSTANTS Technical Report No. 24**

P. J. Rudnik, A. D. Krawitz, D. G. Reichel, and J. B. Cohen Jul. 1987 21 p Prepared in cooperation with Missouri Univ., Columbia

(Contract N00014-80-C-0116; Grant NSF DMR-82-16972)

(AD-A183236) Avail: NTIS HC A02/MF A01 CSCL 20K

From this study, one can conclude that, for a sample without a large stress gradient, the diffraction elastic constants should not be dependent upon the radiation source which is used to measure them. Nor are they dependent upon whether uniaxial tension or four-point bending is used. This is, of course, just a beginning; future experiments must address the effects of a large stress gradient in the sample. This is necessary not merely as a logical next step, but because it is also a more realistic representation of typical residual stress samples. GRA

**N87-29893#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Mathematics.

**MODELING AND COMPUTATIONAL ALGORITHMS FOR PARAMETER ESTIMATION AND OPTIMAL CONTROL OF AEROELASTIC SYSTEMS AND LARGE FLEXIBLE STRUCTURES Final Report, 30 Sep. 1985 - 30 Sep. 1986**

J. A. Burns and E. M. Cliff 1 Nov. 1986 5 p

(Grant AF-AFOSR-0287-85)

(AD-A183302; AFOSR-87-0956TR) Avail: NTIS HC A02/MF A01 CSCL 20K

The goal of this research is to develop computational algorithms for identifications and control, especially with application to aeroelastic and viscoelastic systems. The research has emphasized development of Chandresekhar algorithms for optimal control of distributed systems and state models and computational algorithms for aeroelastic control systems. During this period, the investigators developed fast algorithms for the general linear quadratic optimal control problems for functional differential equations using Chandresekhar factorization techniques. The resulting algorithms show improved rates of convergence over Ricatti techniques and for certain large problems is the only algorithms which was shown to converge in practice. Nine publications were produced during this period under this grant, including Factorization and Reduction Methods for Optimal Control of Hereditary Systems and Modeling and Approximation for a Viscoelastic Control Problem. GRA

**N87-29894#** Dayton Univ., Ohio.

**STRAIN BASED COMPLIANCE METHOD FOR DETERMINING CRACK LENGTH FOR A C(T) (COMPACT-TYPE) SPECIMEN Interim Report, Aug. 1983 - May 1985**

D. C. Maxwell Jul. 1987 32 p

(Contracts F33615-84-C-5051; F33615-81-C-5015)

(AD-A183455; AFWAL-TR-87-4046) Avail: NTIS HC A03/MF A01 CSCL 20K

This report describes the estimation of crack length values based on back-surface strain measurements in a compact-type, C(T), specimen. The method of crack length determination is well suited for use with closed-loop computer controlled test systems. A finite element analysis is used to determine the theoretical back-face strain values for crack length (a) to width (W) ratios from 0.2 to 0.8 and a mathematical relationship for back-face strain compliance as a function of a/W is derived. The a/W values calculated from measured strain compliance are compared with those calculated from crack-mouth-opening-displacement, CMOD, compliance. The variation in a/W predicted from measured strain compliance as compared to a/W predicted from CMOD compliance is approximately + 2 percent at a/W = 0.2 to - 2 percent at a/W = 0.8. A second strain measurement location is determined which enhances the sensitivity of the back-face strain compliance for a/W values from 0.2 to 0.5 and a mathematical relationship of dual-location strain compliance to crack length ratios is derived. GRA

**N87-29895#** Maryland Univ., College Park. Dept. of Aerospace Engineering.

**A SIXTEEN NODE SHELL ELEMENT WITH A MATRIX STABILIZATION SCHEME Interim Report, Oct. 1986 - Mar. 1987**

J. J. Rhiu and S. W. Lee 22 Apr. 1987 49 p

(Contract N00014-84-K-0385)

(AD-A183955) Avail: NTIS HC A03/MF A01 CSCL 20K

A sixteen node shell element is developed using a matrix stabilization scheme based on the Hellinger-Reissner principle with independent strain. Initially the assumed independent strain is divided into a lower order part and a higher order part. The stiffness matrix corresponding to the lower order assumed strain is equivalent to the stiffness matrix of the assumed displacement model element with the reduced integration scheme. The spurious kinematic modes of the element are suppressed by introducing a stabilization matrix associated with a judiciously chosen set of higher order assumed strain fields. Numerical results show that this element is free of locking even for very thin plates and shells. Author (GRA)

**N87-29896*#** Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

**THERMO-ELASTO-VISCOPLASTIC ANALYSIS OF PROBLEMS IN EXTENSION AND SHEAR**

R. Riff and G. J. Simitses [1987] 20 p

(Grant NAG3-534)

(NASA-CR-181410; NAS 1.26:181410) Avail: NTIS HC A02/MF A01 CSCL 20K

The problems of extension and shear behavior of structural elements made of carbon steel and subjected to large thermomechanical loads are investigated. The analysis is based on nonlinear geometric and constitutive relations, and is expressed in a rate form. The material constitutive equations are capable of reproducing all nonisothermal, elasto-viscoplastic characteristics. The results of the test problems show that: (1) the formulation can accommodate very large strains and rotations; (2) the model incorporates the simplification associated with rate-insensitive elastic response without losing the ability to model a rate-temperature dependent yield strength and plasticity; and (3) the formulation does not display oscillatory behavior in the stresses for the simple shear problem. Author

**N87-29897*#** Georgia Inst. of Tech., Atlanta.

**THE DYNAMIC ASPECTS OF THERMO-ELASTO-VISCOPLASTIC SNAP-THROUGH AND CREEP BUCKLING PHENOMENA**

R. Riff and G. J. Simitses [1987] 4 p

(Grant NAG3-534)

(NASA-CR-181411; NAS 1.26:181411) Avail: NTIS HC A02/MF A01 CSCL 20K

Use of a mathematical model and solution methodology, to examine dynamic buckling and dynamic postbuckling behavior of shallow arches and spherical caps made of a realistic material and undergoing non-isothermal, elasto-viscoplastic deformation was examined. Thus, geometric as well as material type nonlinearities of higher order are included in this analysis. The

dynamic stability problem is studied under impulsive loading and suddenly applied loading with loads of constant magnitude and infinite duration. A finite element model was derived directly from the incrementally formulated nonlinear shell equations, by using a tensor-oriented procedure. As an example of the results, the time history of the midspan displacement of a damped shallow circular arch is presented. B.G.

**N87-29898*#** Catholic Univ. of America, Washington, D.C. Dept. of Mechanical Engineering.
**OPTIMUM SHAPE CONTROL OF FLEXIBLE BEAMS BY PIEZO-ELECTRIC ACTUATORS**
A. Baz and S. Poh [1987] 35 p
(Grants NAG5-520; NAG5-749)
(NASA-CR-181413; NAS 1.26:181413) Avail: NTIS HC A03/MF A01 CSCL 20K

The utilization of piezoelectric actuators in controlling the static deformation and shape of flexible beams is examined. An optimum design procedure is presented to enable the selection of the optimal location, thickness and excitation voltage of the piezoelectric actuators in a way that would minimize the deflection of the beam to which these actuators are bonded. Numerical examples are presented to illustrate the application of the developed optimization procedure in minimizing structural deformation of beams using ceramic and polymeric piezoelectric actuators bonded to the beams with a typical bonding agent. The obtained results emphasize the importance of the devised rational produce in designing beam-actuator systems with minimal elastic distortions. Author

**N87-29899*#** George Washington Univ., Washington, D.C. Joint Inst. for Advancement of Flight Sciences.
**COMPUTATIONAL PROCEDURES FOR EVALUATING THE SENSITIVITY DERIVATIVES OF VIBRATION FREQUENCIES AND EIGENMODES OF FRAMED STRUCTURES**
Timothy L. Fetterman and Ahmed K. Noor Washington NASA Oct. 1987 88 p
(Grant NAG1-728)
(NASA-CR-4099; NAS 1.26:4099) Avail: NTIS HC A05/MF A01 CSCL 20K

Computational procedures are presented for evaluating the sensitivity derivatives of the vibration frequencies and eigenmodes of framed structures. Both a displacement and a mixed formulation are used. The two key elements of the computational procedure are: (a) Use of dynamic reduction techniques to substantially reduce the number of degrees of freedom; and (b) Application of iterative techniques to improve the accuracy of the derivatives of the eigenmodes. The two reduction techniques considered are the static condensation and a generalized dynamic reduction technique. Error norms are introduced to assess the accuracy of the eigenvalue and eigenvector derivatives obtained by the reduction techniques. The effectiveness of the methods presented is demonstrated by three numerical examples. Author

# 42 GEOSCIENCES (GENERAL)

No abstracts in this category.

# 43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

**N87-29900*#** Lunar and Planetary Inst., Houston, Tex.
**WORKSHOP ON THE EARTH AS A PLANET**
Lewis Ashwal, ed., Kevin Burke, ed., Maarten deWit, ed., and Gordon Wells, ed. 1986 39 p Workshop held in Orlando, Fla., 27 Oct. 1985
(Contract NASw-4066)
(NASA-CR-180543; NAS 1.26:180543; LPI-TR-86-08) Avail: NTIS HC A03/MF A01 CSCL 08E

Topics addressed include: remote sensing; petrology; imaging spectroscopy; structural properties; thermal evolution; Earth mantle; early Earth; and megageomorphology. B.G.

**N87-29901*#** Nebraska Univ., Lincoln. Dept. of Agronomy.
**BIDIRECTIONAL REFLECTANCE MODELING OF NON-HOMOGENEOUS PLANT CANOPIES Final Report, 15 Sep. 1986 - 16 Sep. 1987**
John M. Norman Sep. 1986 36 p
(Grant NAG5-277)
(NASA-CR-181350; NAS 1.26:181350) Avail: NTIS HC A03/MF A01 CSCL 02F

The objective of this research is to develop a 3-dimensional radiative transfer model for predicting the bidirectional reflectance distribution function (BRDF) for heterogeneous vegetation canopies. Leaf bidirectional reflectance and transmittance distribution functions were measured for corn and soybean leaves. The measurements clearly show that leaves are complex scatterers and considerable specular reflectance is possible. Because of the character of leaf reflectance, true leaf reflectance is larger than the nadir reflectances that are normally used to represent leaves. A 3-dimensional reflectance model, named BIGAR (Bidirectional General Array Model), was developed and compared with measurements from corn and soybean. The model is based on the concept that heterogeneous canopies can be described by a combination of many subcanopies, which contain all the foliage, and these subcanopy envelopes can be characterized by ellipsoids of various sizes and shapes. The model/measurement comparison results indicate that this relatively simple model captures the essential character of row crop BRDF's. Finally, two soil BDRF models were developed: one represents soil particles as rectangular blocks and the other represents soil particles as spheres. The sphere model was found to be superior. M.G.

**N87-29902#** Oak Ridge National Lab., Tenn.
**INSTRUCTIONS FOR APPLYING THE MICROCOMPUTER VERSION OF SWANFLOW-2D ON AN IBM PERSONAL COMPUTER**
J. L. Bledsoe and D. E. Fields 1987 99 p
(Contract DE-AC05-84OR-21400)
(DE87-012004; ORNL-6320) Avail: NTIS HC A05

SWANFLOW-2D (Simultaneous Water, Air, and Nonaqueous Phase Flow) is a two-dimensional finite-difference code that simulates the flow of water and an immiscible nonaqueous-phase liquid (NAPL) within and below the vadose zone, that region in the earth above permanent groundwater level. The microcomputer version of this FORTRAN-77 code is for an IBM-PC or IBM-AT. User flexibility in building or editing datasets is provided by SWANEDIT, the problem sets are executed using SWANFLOW-2D, and postprocessing of results to yield a graphical interpretation is done with SWANGRAF. This report is intended to provide the new user of the SWANFLOW package of codes (SWANEDIT, SWANFLOW-2D, and SWANGRAF) with documentation that will assist him in this task. DOE

**N87-29903*#** National Aeronautics and Space Administration, Washington, D.C.
**NASA FACTS: HOW WE GET PICTURES FROM SPACE**
Robert Haynes [1987] 12 p Original document contains color illustrations
(NASA-NF-151/8-86; NAS 1.20:151/8-86) Avail: NTIS HC A02/MF A01 CSCL 22A

The past 25 years of space travel and exploration has generated an unprecedented quantity of data from planetary systems. Images taken in space and telemetered back to Earth have greatly aided scientists in formulating better and more accurate theories about the nature and origin of out solar system. The procedures and spacecraft systems used to gather data are explained. B.G.

**N87-29904#** Technische Hogeschool, Delft (Netherlands). Afdeling der Geodesie.
**THE ESTIMATION OF VARIANCE COMPONENTS IN GEODETIC NETWORKS Thesis [HET SCHATTEN VAN VARIANTIECOMPONENTEN IN GEODETISCHE NETWERKEN]**
Cornelis Bos Aug. 1986 63 p In DUTCH
(B8681154; ETN-87-90171) Avail: NTIS HC A04/MF A01

Estimates for variance components, in the framework of the adjustment procedure in geodetic networks, were investigated. The fixed effects model, random effects model and mixed model, as well as several algorithms are treated. The Mingue theory is explained. Applications of variance components estimates are presented. Results of calculations on three test networks are discussed. ESA

**N87-29905#** Woods Hole Oceanographic Institution, Mass.
**SATELLITE IMAGE PROCESSING FOR THE AGULHAS RETROFLEXION REGION**
Kelly Luetkemeyer Jul. 1987 83 p
(Contracts N00014-82-C-0019; N00014-87-K-0007)
(AD-A183012; WHOI-87-27) Avail: NTIS HC A05/MF A01 CSCL 08C

In order to analyze the Advanced Very High Resolution Radiometer satellite data from South Africa, a software package has been written. Methodology and algorithms are described which create geometrically corrected registered satellite images over the Agulhas Retroflexion region. Also discussed are programs to overlay latitude and longitude lines, ship tracks, and ancillary data. A method of masking the land and compositing images for cloud removal is also described. GRA

**N87-29906#** Army Cold Regions Research and Engineering Lab., Hanover, N. H.
**USE OF LANDSAT DIGITAL DATA FOR SNOW COVER MAPPING IN THE UPPER SAINT JOHN RIVER BASIN, MAINE**
Carolyn J. Merry and Michael S. Miller Jun. 1987 77 p
(AD-A183213; CRREL-87-8) Avail: NTIS HC A05/MF A01 CSCL 08L

Measurements of snow depth and its water equivalent were obtained at 11 snow courses in the Allagash, Maine, area in conjunction with acquisition of five LANDSAT-2 and -3 images during the 1977 to 1978 and 1978 to 1979 winters. To test a hypothesis that LANDSAT reflected radiance values on a regional scale do change, histograms of the LANDSAT MSS band 7 reflected radiance values for a 300- x 300-pixel (420 sq km) area near Allagash were evaluated to quantify the change. A statistical description (skewness and kurtosis) of the histogram for each scene was developed and then correlated with ground measurements of snow depth. The LANDSAT data were then re-examined and corrections made for solar elevation and MSS sensor calibration. Reflected radiance from open areas showed a consistent increase in intensity with increasing snow depth. Forested land cover classes did not change with snow depth. Digital imagery data acquired 31 May 1978 when the land was snow-free was used to classify land cover categories. Ground truth measurements of water equivalent of the snow cover were area-weighted using the land cover classification to derive regional values on each of the five LANDSAT winter scenes. The 1 March 1978 snow measurement of 19.46 cm of water equivalent was used as an input value to the SSARR model. The SSARR prediction for the 1 March to 31 May 1978 period was within 78% of the measured runoff for the initial baseflow period and within 66% of that measured for the spring melt recession period. GRA

**N87-29907#** Naval Ship Research and Development Center, Bethesda, Md. Ship Performance Dept.
**LABRADOR WIND AND WAVE ENVIRONMENTS Final Report**
Wah T. Lee May 1987 78 p
(AD-A183218; DTNSRDC/SPD-1214-01) Avail: NTIS HC A05/MF A01 CSCL 08C

The Labrador Extreme Waves Experiment (LEWEX) is designed to evaluate the in situ and remote sensors of the sea surface. This report is a source document for specifying climatological wind and wave data for the Labrador Sea. This report also provides atmospheric qualities such as temperature and sea ice which are known to affect the operation of certain ship systems as well as tactical decision making. GRA

**N87-29908#** Operations Research, Inc., Arlington, Va.
**OBSERVATIONS OF SHIP WAKES FROM SPACE-SHUTTLE MISSIONS Final Report**
James M. Witting and Richard F. Hoglund 12 Jun. 1987 72 p
(Contract N00014-86-C-0834)
(AD-A183563; ORI-TR-2727) Avail: NTIS HC A04/MF A01 CSCL 20D

Highly visible features on the ocean surface behind a moving ship are the Kelvin waves, which appear as a regular pattern moving with the ship, and a ribbon trailing the ship's stern marked by less choppy water than the surrounding, produced by the ship's turbulent wake. The simplest analysis of ship waves that derives a basically correct wave pattern is linear water wave theory with a moving steady source. The elevation of the water surface from a simple source moving in a straight line at constant speed is shown. Waves can exist only in the region between +/- inverse (1/3) = +/- 19.47 deg of the center line. On the edges of the pattern the waves form a cusp; their amplitudes are generally at a maximum just inside the cusp lines. The geometry locating wave crests notes that two distinct branches show up, one composed of waves traveling at relatively small angles to the ship direction (the transverse pattern), the other composed of waves traveling at relatively large angles to the ship direction (the divergent pattern). At the cusp line there is a 90 deg phase shift between the two patterns, a feature not shown in most corresponding figures. GRA

**N87-29909#** Army Engineer Topographic Labs., Fort Belvoir, Va.
**A USER'S GUIDE FOR THE ANALYTICAL PHOTOGRAMMETRIC POSITIONING SYSTEM (APPS)**
George E. Newbury Nov. 1986 46 p
(AD-A183773; ETL-0446) Avail: NTIS HC A03/MF A01 CSCL 08B

The Analytical Photogrammetric Positioning System (APPS) and the Automated Geographic Information System (AUTOGIS) are described. The report discusses the recommended approach for using the hardware and software, and gives some examples of projects that may make use of the systems. GRA

**N87-29575#** Joint Publications Research Service, Arlington, Va.
**ANALYSIS OF DIRECTIONS OF LINEAR IMAGE ELEMENTS BY STRUCTURE-ZONAL METHOD Abstract Only**
V. A. Kottsov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 118 Transl. into ENGLISH from Issledovaniye Zemli iz Kosmosa (Moscow, USSR), no. 6, Nov. - Dec. 1986 p 97-100 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

# 44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

**N87-29910#** Pacific Northwest Labs., Richland, Wash.
**PERFORMANCE ISSUES IN SOLAR THERMAL ENERGY TRANSPORT SYSTEMS**
P. W. Zimmerman Jul. 1986 7 p Presented at the ASME/JSME/ISES Solar Energy Conference, Honolulu, Hawaii, 22 Mar. 1987
(Contract DE-AC06-76RL-01830)
(DE87-011336; PNL-SA-14022; CONF-870307-22) Avail: NTIS HC A02

Pacific Northwest Laboratory, sponsored by the US Department of Energy through Sandia National Laboratories, is performing an assessment of three solar thermal electricity generating concepts; central receivers, dishes, and troughs. Concepts are being studied over a range of system sizes 0.5 MWe to 100 MWe with solar multiples from 1.0 to 2.8. Central receiver systems using molten salt, sodium, and water-steam working fluids are studied. The dish system selected for study uses a kinematic Stirling engine at the focal point, and the trough system is based on Accurex designed collectors heating a heat transfer oil. Of the three concepts studied, the central receiver and trough systems utilize thermal transport systems. A thermal transport system is the piping and fluid required to transfer thermal energy between receiver, and storage and between storage and steam generator. The literature contains many transport system designs, most of which are optimized with regard to cost and performance. We used the parameters specified from the optimizations to design our systems and scale the designs over the 0.5 MWe to 100 MWe size range. From these designs, thermal losses and pump sizes are derived then combined in a system model to obtain total annual averaged efficiency as a function of plant field size. We found that central receiver transport efficiency improves with field size whereas trough transport efficiency degrades with field size. We found that overnight cooldown accounts for roughly 50% of the total thermal losses for all transport systems. Trough performance is substantially degraded because the receiver tubes are not drained which allows a large overnight heat loss. Trough transport performance was found to be sensitive to fluid velocity. DOE

**N87-29911#** Hughes Aircraft Co., Long Beach, Calif.
**MODULAR ARRAY FIELD DESIGNS FOR TRACKING FLAT-PLATE PHOTOVOLTAIC SYSTEMS, VOLUME 1**
J. A. Castle Jun. 1987 407 p Prepared in cooperation with Sandia National Labs., Albuquerque, N. Mex.
(DE87-011607; SAND-86-7036-Vol-1) Avail: NTIS HC A18/MF A01

This report addresses the optimization of utility-sized, tracking flat-plate photovoltaic power systems. Structures optimized were one single-axis and one dual-axis tracking system using currently available system designs as baseline engineering reference points. Passive thermal-hydraulic tracking drive systems were evaluated and Freon-hydraulic units were found to be cost-effective in single-axis tracking. Building block configurations ranging in size from 35 kW to 5 MW were established using the optimized single- and dual-axis tracking structures, and their reliability and availability were analyzed. A 1-MW single-axis building block design was selected to develop engineering plans for a 100-MW PV power plant designed to operate unattended. Eleven-percent efficient PV panels at $220/sq m were used in the study, and single-axis, flat-plate tracking systems were found to be significantly more cost-effective than dual-axis systems. A prototype tracking array was built and tested at Sandia, where cost and performance data supported lower economic projections for large PV tracking arrays. DOE

**N87-29912#** Oak Ridge National Lab., Tenn.
**OPTIMIZATION AND ANALYSIS OF LiH THERMAL ENERGY STORAGE DEVICE CONFIGURATIONS FOR SPACE POWER APPLICATIONS**
M. Siman-Tov, P. Williams, and M. Olszewski 1987 22 p Presented at the 22nd Intersociety Energy Conversion Engineering Conference, Philadelphia, Pa., 10 Aug. 1987
(Contract DE-AC05-84OR-21400)
(DE87-010404; CONF-870804-7) Avail: NTIS HC A02/MF A01

Thermal energy storage (TES) can be used to reduce the area and mass of the heat rejection system for space-based sprint power systems. During the sprint mode power cycle, reject heat is placed into storage. The heat is then rejected to the ultimate sink over the much longer non-operational portion of the orbits, through a correspondingly smaller radiator. Preliminary analysis has shown significant weight advantage for the heat storage plus radiator concept over the radiator only concept. Thermal performance analysis and optimization of five heat sink TES configurations using LiH was completed. The configurations are: (1) LiH encapsulated spheres in the packed bed, (2) standard tube and shell arrangement with LiH on the tube side, (3) tube and shell with LiH on the shell side, (4) alternating concentric rings of LiH and heat transport fluid, and (5) parallel slabs of LiH. System performance was calculated for a wide range of parameters and included effects of prespecified internal voids, enhanced conductivity and internal fins. DOE

**N87-29913#** Bechtel Corp., Los Angeles, Calif. Research and Development.
**THE INTEGRATION OF 1990S THIN-FILM TECHNOLOGIES INTO PHOTOVOLTAIC SYSTEM DESIGN**
W. J. Stolte May 1987 169 p
(Contract DE-AC04-76DP-00789)
(DE87-011581; SAND-87-7008) Avail: NTIS HC A08/MF A01

This report addresses the integration of 1990s timeframe thin-film flat-plate modules into system design. It includes the results of an industry survey to determine the characteristics of such future thin-film modules and the characteristics of a range of postulated module configurations. Impacts on balance-of-plant designs were evaluated for fixed, single-axis tracking and dual-axis tracking arrays in utility-scale plants using postulated low-voltage thin-film module counterparts of present crystalline silicon modules. Intermediate and high-voltage modules more suited to thin-film technology were used in developing plant design modifications to optimally incorporate such future modules. Blocking diode placement, the economics of replacing failed modules, dc field wiring optimization, and additional topics were also addressed. No mechanical or structural design changes were found to be necessary to integrate thin-film modules into existing system designs. Changes to the electrical designs mostly involved slight changes to equipment ratings or panel wiring and were considered to be insignificant. Cost impacts were minor, on the order of one cent per watt. It was found that blocking diode placement should be determined experimentally by the manufacturers, with calculations used only as a guide. DOE

**N87-29914*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**SPACE ELECTROCHEMICAL RESEARCH AND TECHNOLOGY (SERT)**
Sep. 1987 364 p Conference held in Cleveland, Ohio, 14-16 Apr. 1987
(NASA-CP-2484; E-3506; NAS 1.55:2484) Avail: NTIS HC A16/MF A01 CSCL 10C

The conference provided a forum to assess critical needs and technologies for the NASA electrochemical energy conversion and storage program. It was aimed at providing guidance to NASA on the appropriate direction and emphasis of that program. A series of related overviews were presented in the areas of NASA advanced mission models (space stations, low and geosynchronous Earth orbit missions, planetary missions, and space transportation). Papers were presented and workshops conducted in a variety of technical areas, including advanced rechargeables, advanced

concepts, critical physical electrochemical issues, and modeling. For individual titles, see N87-29915 through N87-29945.

**N87-29915*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**STATUS OF SPACE STATION POWER SYSTEM** **c18**
Cosmo R. Baraona and Dean W. Sheibley *In its* Space Electrochemical Research and Technology (SERT) Sep. 1987 p 1-8 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 22B

The major requirements and guidelines that affect the manned space station configuration and the power systems are explained. The evolution of the space station power system from the NASA program development feasibility phase through the current preliminary design phase is described. Several early station concepts are described and linked to the present concept. The recently completed phase B tradeoff study selections of photovoltaic system technologies are described. The present solar dynamic and power management and distribution systems are also summarized for completeness. Author

**N87-29916*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**LEO AND GEO MISSIONS** **c12**
Enrico Mercanti *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 9-14 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 22A

The occurrence of the Challenger disaster in early 1986 caused a severe reevaluation of the space program. Plans already established had to be drastically revised and new plans had to be made. NASA created the Space Leadership Planning Group (SLPG) to formulate space mission plans covering a 50 year period based on Agency goals and objectives responsive to the National Commission on Space recommendations. An interim view of the status of SLPG plans for low altitude and geosynchronous missions is presented. Author

**N87-29917*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**JPL FUTURE MISSIONS AND ENERGY STORAGE TECHNOLOGY IMPLICATIONS Abstract Only**
Eugene V. Pawlik *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 15 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

The mission model for JPL future programs is presented. This model identifies mission areas where JPL is expected to have a major role and/or participate in a significant manner. These missions are focused on space science and applications missions, but they also include some participation in space station activities. The mission model is described in detail followed by a discussion on the needs for energy storage technology required to support these future activities. Author

**N87-29918*#** Aerospace Corp., Los Angeles, Calif.
**A VIEW FROM THE AIAA: INTRODUCTION OF NEW ENERGY STORAGE TECHNOLOGY INTO ORBITAL PROGRAMS**
Charles Badcock *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 17-21 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

The development of new energy storage technology must be heavily weighted toward the application. The requirements for transitioning low risk technology into operational space vehicles must remain the central theme even at the preliminary development stages by the development of efforts to define operational issues and verify the reliability of the system. Failure to follow a complete plan that results in a flight qualified unit may lead to an orphan technology. Development efforts must be directed toward a stable development where changes in design are evolutionary and end items are equivalent to flight units so that life and qualification testing can be used as a vehicle to demonstrate the acceptability of the technology. Author

**N87-29919*#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
**AIR FORCE ELECTROCHEMICAL POWER RESEARCH AND TECHNOLOGY PROGRAM FOR SPACE APPLICATIONS**
Douglas Allen *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 23-28 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

An overview is presented of the existing Air Force electrochemical power, battery, and fuel cell programs for space application. Present thrusts are described along with anticipated technology availability dates. Critical problems to be solved before system applications occur are highlighted. Areas of needed performance improvement of batteries and fuel cells presently used are outlined including target dates for key demonstrations of advanced technology. Anticipated performance and current schedules for present technology programs are reviewed. Programs that support conventional military satellite power systems and special high power applications are reviewed. Battery types include bipolar lead-acid, nickel-cadmium, silver-zinc, nickel-hydrogen, sodium-sulfur, and some candidate advanced couples. Fuel cells for pulsed and transportation power applications are discussed as are some candidate advanced regenerative concepts. Author

**N87-29920*#** Hughes Research Labs., Malibu, Calif.
**KOH CONCENTRATION EFFECT ON CYCLE LIFE OF NICKEL-HYDROGEN CELLS**
Hong S. Lim and S. A. Verzwyvelt *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 29-39 Submitted for publication (For primary document see N87-29914 24-44)
(Contract NAS3-22238)
Avail: NTIS HC A16/MF A01 CSCL 10C

A cycle life test of Ni/H2 cells containing electrolytes of various KOH concentrations and a sintered type nickel electrode was carried out at 23 C using a 45 min accelerated low Earth orbit (LEO) cycle regime at 80 percent depth of discharge. One of three cells containing 26 percent KOH has achieved over 28,000 cycles, and the other two 19,000 cycles, without a sign of failure. Two other cells containing 31 percent KOH electrolyte, which is the concentration presently used in aerospace cells, failed after 2,979 and 3,620 cycles. This result indicates that the cycle life of the present type of Ni/H2 cells may be extended by a factor of 5 to 10 simply by lowering the KOH concentration. Long cycle life of a Ni/H2 battery at high depth-of-discharge operation is desired, particularly for an LEO spacecraft application. Typically, battery life of about 30,000 cycles is required for a five year mission in an LEO. Such a cycle life with presently available cells can be assured only at a very low depth-of-discharge operation. Results of testing already show that the cycle life of an Ni/H2 cell is tremendously improved by simply using an electrolyte of low KOH concentration. Author

**N87-29921*#** Communications Satellite Corp., Clarksburg, Md.
**LONG-TERM STORAGE OF NICKEL-HYDROGEN CELLS**
Hari Vaidyanathan *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 41-48 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

Representative samples of nickel hydrogen cells for the INTELSAT program were used to evaluate the effects of prolonged storage under passive conditions such as open circuit discharged at 0 C, room temperature, and -20 C, and under quasidynamic conditions such as top-off charge and trickle charge. Cell capacity declines when cells are stored open-circuit discharged at room temperature, and a second plateau occurs in the discharge curve. Capacity loss was 47 percent for a cell with hydrogen precharge and 24.5 percent for one with no hydrogen precharge. Capacity recovery was observed following top-off charge storage of cells which had exhibited faded capacity as a result of passive storage

at room temperature. Cells stored either at -20 C or on trickle charge maintained their capacity. At 0 C storage, the capacity of all three cells under tests was greater than 55 Ah (which exceeds the required minimum of 44 Ah) after 7 months. Author

**N87-29922*#** Johnson Controls, Inc., Milwaukee, Wis.
**COST REDUCTIONS IN NICKEL-HYDROGEN BATTERY**
Richard L. Beauchamp and Jack F. Sindorf *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 49-61 Previously announced as N87-23881 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

Significant progress was made toward the development of a commercially marketable hydrogen nickel oxide battery. The costs projected for this battery are remarkably low when one considers where the learning curve is for commercialization of this system. Further developmental efforts on this project are warranted as the H2/NiO battery is already cost competitive with other battery systems. E.R.

**N87-29923*#** Hughes Aircraft Co., Los Angeles, Calif.
**ADVANCED NICKEL-CADMIUM BATTERIES FOR GEOSYNCHRONOUS SPACECRAFT**
David F. Pickett, Hong S. Lim, Stanley J. Krause, and Scott A. Verzwyvelt *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 63-80 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

A nickel cadmium battery was developed that can be operated at 80 percent depth of discharge in excess of 10 years in a geosynchronous orbit application, and has about a 30 percent weight savings per spacecraft over present nickel cadmium batteries when used with a 1000 watts eclipse load. The approach used in the development was to replace nylon separators with inert polymer impregnated zirconia, use electrochemically deposited plates in place of conventional chemically precipitated ones, and use an additive to extend negative plate lifetime. The design has undergone extensive testing using both engineering and protoflight cell configurations. Author

**N87-29924*#** Eltech Systems, Inc., Fairport Harbor, Ohio.
**ALUMINUM-OXYGEN BATTERIES FOR SPACE APPLICATIONS**
Marilyn J. Niksa and Douglas J. Wheeler *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 81-88 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

An aluminum oxygen fuel cell is under development. Several highly efficient cell designs were constructed and tested. Air cathodes catalyzed with cobalt tetramethoxy porphorin have demonstrated more than 2000 cycles in intermittant use conditions. Aluminum alloys have operated at 4.2 kWH/kg at 200 mA/sq cm. A novel separator device, an impeller fluidizer was coupled with the battery to remove the solid hydrargillite discharge product. A 60 kW, 720 kWH battery system is projected to weigh about 2200 lbs., for an energy density of 327 WH lb. Author

**N87-29925*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**DEVELOPMENT OF AMBIENT TEMPERATURE SECONDARY LITHIUM CELLS**
S. Subbarao, D. H. Shen, S. Dawson, F. Deligiannis, J. Taraszkiewicz, and Gerald Halpert *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 89-95 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

JPL is developing ambient temperature secondary lithium cells for future spacecraft applications. Prior studies on experimental laboratory type Li-TiS2 cells yielded promising results in terms of cycle life and rate capability. To further assess the performance of this cell, 5 Ah engineering model cells were developed. Initially baseline cells were designed and fabricated. Each cell had 15 cathodes and 16 anodes and the ratio of anode to cathode capacity is 6:1. A solution of 1.5 molar LiAsF6 in 2Me-THF was used as the electrolyte. Cells were evaluated for their cycle life at C/1 and C/5 discharge rates and 100 percent depth of discharge. The cells were cycled between voltage limits 1.7 and 2.8 volts. The rate of charge in all cases is C/10. The results obtained indicate that cells can operate at C/10 to C/2 discharge rates and have an initial energy density of 70 Wh/kg. Cells delivered more than 100 cycles at C/2 discharge rate. The details of cell design, the test program, and the results obtained are described. Author

**N87-29926*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**DEVELOPMENT OF LITHIUM-THIONYL CHLORIDE BATTERIES FOR CENTAUR**
Gerald Halpert, Harvey Frank, and Ralph Lutwack *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 97-101 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

Lithium thionyl chloride (LiSOCl2) primary cells and batteries have received considerable attention over the last several years because of their high theoretical specific energy and energy density. The objective was to develop a 300 wh/kg cell capable of safe operation at C/2 rate and active storage life for 5 to 10 years. This technology would replace other primary cell technologies in NASA applications mainly the silver zinc (AgZn) batteries presently in use. The LiSOCl2 system exceeds the capabilities of the AgZn in terms of specific energy of 300 wh/kg (compared with 100 wh/kg for AgZn), active storage life of 10 to 20 times the 3 to 6 months active storage and has a significantly lower projected cost. Author

**N87-29927*#** Brigham Young Univ., Provo, Utah. Dept. of Chemical Engineering.
**Na/BETA-ALUMINA/NaAlCl4, Cl2/C CIRCULATING CELL**
Jing-Yih Cherng and Douglas N. Bennion *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 103-10 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

A study was made of a high specific energy battery based on a sodium negative electrode and a chlorine positive electrode with molten AlCl3-NaCl electrolyte and a solid beta alumina separator. The basic performance of a Na beta-alumina NaAlCl4, Cl2/C circulating cell at 200 C was demonstrated. This cell can be started at 150 C. The use of melting sodium chloroaluminate electrolyte overcomes some of the material problems associated with the high working temperatures of present molten salt systems, such as Na/S and LiAl/FeS, and retains the advantages of high energy density and relatively efficient electrode processes. Preliminary investigations were conducted on a sodium-chlorine static cell, material compability, electrode design, wetting, and theoretical calculations to assure a better chance of success before assembling a Na/Cl2 circulating cell. Mathematical models provide a theoretical explanation for the performance of the NaCl2 battery. The results of mathematical models match the experimental results very well. According to the result of the mathematical modeling, an output at 180 mA/sq cm and 3.2 V can be obtained with optimized cell design. Author

**N87-29928*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**DEVELOPMENT OF NEW SEALED BIPOLAR LEAD-ACID BATTERY**
Alan I. Attia and J. J. Rowlette *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 105-11 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

New light weight composite bipolar plates which can withstand the corrosive environment of the lead acid battery have made possible the construction of a sealed bipolar lead acid battery

that promises to achieve very high specific power levels and substantially higher energy densities than conventional lead acid batteries. Performance projections based on preliminary experimental results show that the peak specific power of the battery can be as high as 90 kW/kg, and that a specific power of 5 kW/kg can be sustained over several thousand pulses. Author

**N87-29929*#** Eltron Research, Inc., Aurora, Ill.
**ELECTROCHEMICAL GENERATION OF USEFUL CHEMICAL SPECIES FROM LUNAR MATERIALS**
Anthony F. Sammells and Krystyna W. Semkow *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 119-12 (For primary document see N87-29914 24-44)
(Contract NAS9-17743)
Avail: NTIS HC A16/MF A01 CSCL 10C

A high temperature electrolytic cell which simultaneously generates oxygen at the anode and liquid alkali metals at the cathode is electrochemically characterized. The electrolytic technology being investigated utilizes the oxygen vacancy conducting solid electrolyte, yttria stabilized zirconia, which effectively separates the oxygen evolving (at La0.89Sr0.10MnO3) and alkali metal (Li, Na) reducing (from a molten salt at either Pt or FeSi2) half cell reactions. In the finally engineered cell liquid alkali metal would be continuously removed from the cathode compartment and used as an effective reductant for the direct thermochemical refining of lunar ores to their metallic state with simultaneous oxidation of the alkali metal to its oxide. The alkali metal oxide would then be reintroduced into the electrolytic cell to complete the overall system cycle. Author

**N87-29930*#** International Fuel Cells Corp., South Windsor, Conn.
**ADVANCED FUEL CELL CONCEPTS FOR FUTURE NASA MISSIONS Abstract Only**
J. K. Stedman *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 125 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

Studies of primary fuel cells for advanced all electric shuttle type vehicles show an all fuel cell power system with peak power capability of 100's of kW to be potentially lighter and have lower life cycle costs than a hybrid system using advanced H2O2 APU's for peak power and fuel cells for low power on orbit. Fuel cell specific weights of 1 to 3 lb/kW, a factor of 10 improvement over the orbiter power plant, are projected for the early 1990's. For satellite applications, a study to identify high performance regenerative hydrogen oxygen fuel cell concepts for geosynchronous orbit was completed. Emphasis was placed on concepts with the potential for high energy density (Wh/lb) and passive means for water and heat management to maximize system reliability. Both alkaline electrolyte and polymer membrane fuel cells were considered. Author

**N87-29931*#** Giner, Inc., Waltham, Mass.
**ADVANCED HYDROGEN ELECTRODE FOR HYDROGEN-BROMIDE BATTERY**
Jack A. Kosek and Anthony B. LaConti *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 127-13 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

Binary platinum alloys are being developed as hydrogen electrocatalysts for use in a hydrogen bromide battery system. These alloys were varied in terms of alloy component mole ratio and heat treatment temperature. Electrocatalyst evaluation, performed in the absence and presence of bromide ion, includes floating half cell polarization studies, electrochemical surface area measurements, X ray diffraction analysis, scanning electron microscopy analysis and corrosion measurements. Results obtained to date indicate a platinum rich alloy has the best tolerance to bromide ion poisoning. Author

**N87-29932*#** Maryland Univ., College Park. Dept. of Mechanical Engineering.
**SATELLITE POWER USING MAGNETICALLY SUSPENDED FLYWHEEL STACK**
James A. Kirk and Davinder K. Anand (Technical Planning, Inc., Beltsville, Md.) *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 137-14 (For primary document see N87-29914 24-44)
(Contract NAS5-29272)
Avail: NTIS HC A16/MF A01 CSCL 10C

Research activities with magnetically suspended flywheels are reported. The purpose of the effort is to critically examine and further the development of all the key technologies which impact the inertial energy storage system. The results presented discuss the concept of a magnetically suspended flywheel as it applies to a 500 Watt-hour energy storage system. The proposed system is currently under hardware development and is based upon two pancake magnetic bearings arranged in a vertical stack. Author

**N87-29933*#** Oak Ridge National Lab., Tenn.
**APPLICATION OF ADVANCED FLYWHEEL TECHNOLOGY FOR ENERGY STORAGE ON SPACE STATION**
Mitchell Olszewski *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 147-15 Previously announced as N87-24028 (For primary document see N87-29914 24-44)
(Contract DE-AC05-84OR-21400)
Avail: NTIS HC A16/MF A01 CSCL 10C

In space power applications where solar inputs are the primary thermal source, energy storage is necessary to provide a continuous power supply during the eclipse portion of the orbit. Because of their potentially high storage density, flywheels are being considered for use as the storage system on the proposed orbiting space station. During the past several years, graphite fiber technology has advanced, leading to significant gains in flywheel storage density. Use of these improved fibers in experimental flywheel rims has resulted in ultimate storage densities of 878 kJ/kg. With these high strength graphite fibers, operational storage densities for flywheel storage modules applicable to the space station power storage could reach 200 kJ/kg. This module would also be volumetrically efficient occupying only about 1 cu m. Because the size and mass of the flywheel storage module are controlled by the storage density, improvements in fiber strength can have a significant impact on these values. With the improvements anticipated within the next five years, operational storage density on the order of 325 kJ/kg may be possible for the flywheel module. Author

**N87-29934*#** Brookhaven National Lab., Upton, N. Y. Dept. of Applied Science.
**EXAFS: NEW TOOL FOR STUDY OF BATTERY AND FUEL CELL MATERIALS**
James McBreen, William E. OGrady, and Kaumudi I. Pandya (Case Western Reserve Univ., Cleveland, Ohio.) *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 157-17 (For primary document see N87-29914 24-44)
(Contract DE-AC05-80ER-10742)
Avail: NTIS HC A16/MF A01 CSCL 10C

Extended X ray absorption fine structure (EXAFS) is a powerful technique for probing the local atomic structure of battery and fuel cell materials. The major advantages of EXAFS are that both the probe and the signal are X rays and the technique is element selective and applicable to all states of matter. This permits in situ studies of electrodes and determination of the structure of single components in composite electrodes, or even complete cells. EXAFS specifically probes short range order and yields coordination numbers, bond distances, and chemical identity of nearest neighbors. Thus, it is ideal for structural studies of ions in solution and the poorly crystallized materials that are often the active materials or catalysts in batteries and fuel cells. Studies on typical battery and fuel cell components are used to describe the technique and the capability of EXAFS as a structural tool in these

applications. Typical experimental and data analysis procedures are outlined. The advantages and limitations of the technique are also briefly discussed. Author

**N87-29935*#** Stanford Univ., Calif. Dept. of Materials Science.
**POLYPHASE ALLOYS AS RECHARGEABLE ELECTRODES IN ADVANCED BATTERY SYSTEMS**
Robert A. Huggins *In* NASA-Lewis Research Center, Spcae Electrochemical Research and Technology (SERT) Sep. 1987 p 179-18 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

The rechargeability of electrochemical cells is often limited by negative electrode problems. These may include loss of capacity, increased impedance, macroscopic shape change, dendrite growth, or a tendency for filamentary or whisker growth. In principle, these problems can be reduced or eliminated by the use of alloys that undergo either displacement or insertion reactions at reactant species activities less than unity, rather than pure elements. The fundamental reasons for some of these problems with elemental electrodes, as well as the basic principles involved in the different behavior of alloys, are briefly discussed. More information is now available concerning the thermodynamic and kinetic properties of a number of alloys of potential interest for use as electrodes in elevated temperature lithium battery systems. Recent results have extended these results down to ambient temperatures, indicating that some such materials may be of interest for use with new low temperature molten salt electrolytes, or with organic solvent electrolytes. The all solid mixed conductor matrix concept is also reviewed. Author

**N87-29936*#** Michigan Technological Univ., Houghton. Dept. of Chemistry and Chemical Engineering.
**STRUCTURAL MODELS FOR NICKEL ELECTRODE ACTIVE MASS**
Bahne C. Cornilsen, P. J. Karjala, and P. L. Loyselle *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 191-19 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

Raman spectroscopic data allow one to distinguish nickel electrode active mass, alpha and beta phase materials. Discharges active mass is not isostructural with beta-Ni(OH)2. This is contrary to the generally accepted model for the discharged beta phase of active mass. It is concluded that charged active mass displays a disordered and nonstoichiometric, nonclose packed structure of the R3 bar m, NiOOH structure type. Raman spectral data and x ray diffraction data are analyzed and shown to be consistent with this structural model. Author

**N87-29937*#** Los Alamos National Lab., N. Mex.
**ADVANCES IN SOLID POLYMER ELECTROLYTE FUEL CELL TECHNOLOGY WITH LOW-PLATINUM-LOADING ELECTRODES**
Supramaniam Srinivasan, E. A. Ticianelli, C. R. Derouin, and A. Redondo *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p197-21 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

The Gemini Space program demonstrated the first major application of fuel cell systems. Solid polymer electrolyte fuel cells were used as auxiliary power sources in the spacecraft. There has been considerable progress in this technology since then, particularly with the substitution of Nafion for the polystyrene sulfonate membrane as the electrolyte. Until recently the performance was good only with high platinum loading (4 mg/sq cm) electrodes. Methods are presented to advance the technology by (1) use of low platinum loading (0.35 mg/sq cm) electrodes; (2) optimization of anode/membrane/cathode interfaces by hot pressing; (3) pressurization of reactant gases, which is most important when air is used as cathodic reactant; and (4) adequate humidification of reactant gases to overcome the water management problem. The high performance of the fuel cell with the low loading of platinum appears to be due to the extension of the three dimensional reaction zone by introduction of a proton conductor, Nafion. This was confirmed by cyclic voltammetry. Author

**N87-29938*#** Texas A&M Univ., College Station. Dept. of Chemical Engineering.
**REGENERATIVE FUEL CELLS FOR SPACE APPLICATIONS**
A. John Appleby *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 213-22 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

After several years of development of the regenerative fuel cell (RFC) as the electrochemical storage system to be carried by the future space station, the officiai stance has now been adopted that nickel hydrogen batteries would be a better system choice. RFCs are compared with nickel hydrogen and other battery systems for space platform applications. Author

**N87-29939*#** Case Western Reserve Univ., Cleveland, Ohio. Dept. of Chemistry.
**PEROVSKITE OXIDES: OXYGEN ELECTROCATALYSIS AND BULK STRUCTURE**
R. E. Carbonio (Universidad Nacional de Cordoba, Argentina ), C. Fierro, D. Tryk, D. Scherson, and Ernest Yeager *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 221-23 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

Perovskite type oxides were considered for use as oxygen reduction and generation electrocatalysts in alkaline electrolytes. Perovskite stability and electrocatalytic activity are studied along with possible relationships of the latter with the bulk solid state properties. A series of compounds of the type LaFe(x)Ni1(-x)O3 was used as a model system to gain information on the possible relationships between surface catalytic activity and bulk structure. Hydrogen peroxide decomposition rate constants were measured for these compounds. Ex situ Mossbauer effect spectroscopy (MES), and magnetic susceptibility measurements were used to study the solid state properties. X ray photoelectron spectroscopy (XPS) was used to examine the surface. MES has indicated the presence of a paramagnetic to magnetically ordered phase transition for values of x between 0.4 and 0.5. A correiation was found between the values of the MES isomer shift and the catalytic activity for peroxide decomposition. Thus, the catalytic activity can be correlated to the d-electron density for the transition metal cations. Author

**N87-29940*#** Giner, Inc., Waltham, Mass.
**OXYGEN ELECTRODES FOR RECHARGEABLE ALKALINE FUEL CELLS**
Larry Swette and Jose Giner *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 237-24 (For primary document see N87-29914 24-44) (Contract NAS3-24635)
Avail: NTIS HC A16/MF A01 CSCL 10C

Electrocatalysts and supports for the positive electrode of moderate temperature single unit rechargeable alkaline fuel cells were investigated and developed. The electrocatalysts are defined as the material with a higher activity for the oxygen electrode reaction than the support. Advanced development will require that the materials be prepared in high surface area forms, and may also entail integration of various candidate materials. Eight candidate support materials and seven electrocatalysts were investigated. Of the 8 support, 3 materials meet the preliminary requirements in terms of electrical conductivity and stability. Emphasis is now on preparing in high surface area form and testing under more severe corrosion stress conditions. Of the 7 electrocatalysts prepared and evaluated, at least 5 materials remain as potential candidates. The major emphasis remains on preparation, physical characterization and electrochemical performance testing. Author

**N87-29941*#** Physical Sciences, Inc., Andover, Mass.
**HIGH-SURFACE-AREA, DUAL-FUNCTION OXYGEN ELECTROCATALYSTS FOR SPACE POWER APPLICATIONS**
David O. Ham, Gary Moniz, and E. Jennings Taylor *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 245-25 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

The processes of hydration/dehydration and carbonation/decarbonation are investigated as an approach to provide higher surface area mixed metal oxides that are more active electrochemically. These materials are candidates for use as electrocatalysts and electrocatalyst supports for alkaline electrolyzers and fuel cells. For the case of the perovskite, LaCoO3, higher surface areas were achieved with no change in structure and a more active oxygen electrocatalyst. Author

**N87-29942*#** SRI International Corp., Menlo Park, Calif.
**AC IMPEDANCE STUDY OF DEGRADATION OF POROUS NICKEL BATTERY ELECTRODES**
Stephen J. Lenhart, D. D. Macdonald, and B. G. Pound *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 257-28 (For primary document see N87-29914 24-44)
(Contract LBL-712955)
Avail: NTIS HC A16/MF A01 CSCL 10C

AC impedance spectra of porous nickel battery electrodes were recorded periodically during charge/discharge cycling in concentrated KOH solution at various temperatures. A transmission line model (TLM) was adopted to represent the impedance of the porous electrodes, and various model parameters were adjusted in a curve fitting routine to reproduce the experimental impedances. Degradation processes were deduced from changes in model parameters with electrode cycling time. In developing the TLM, impedance spectra of planar (nonporous) electrodes were used to represent the pore wall and backing plate interfacial impedances. These data were measured over a range of potentials and temperatures, and an equivalent circuit model was adopted to represent the planar electrode data. Cyclic voltammetry was used to study the characteristics of the oxygen evolution reaction on planar nickel electrodes during charging, since oxygen evolution can affect battery electrode charging efficiency and ultimately electrode cycle life if the overpotential for oxygen evolution is sufficiently low. Author

**N87-29943*#** Rochester Univ., N. Y. Dept. of Chemical Engineering.
**ELECTROCHEMICAL IMPREGNATION OF NICKEL HYDROXIDE IN POROUS ELECTRODES** **c25**
Kuo-Chuan Ho and Jacob Jorne *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 285-30 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 07D

The electrochemical impregnation of nickel hydroxide in porous electrode was investigated both experimentally and theoretically. The loading level and plaque expansion were the most important parameters to be considered. The effects of applied current density, stirring, ratio of solution to electrode volume and pH were identified. A novel flow through electrochemical impregnation is proposed in which the electrolyte is forced through the porous nickel plaque. The thickening of the plaque can be reduced while maintaining high loading capacity. A mathematical model is presented which describes the transport of the nitrate, nickel and hydroxyl ions and the consecutive heterogeneous electrochemical reduction of nitrate and the homogeneous precipitation reaction of nickel hydroxide. The distributions of precipitation rate and active material within the porous electrode are obtained. A semiempirical model is also proposed which takes into account the plugging of the pores. Author

**N87-29944*#** Case Western Reserve Univ., Cleveland, Ohio. Dept. of Chemical Engineering.
**EFFECT OF STRUCTURE ON CURRENT AND POTENTIAL DISTRIBUTIONS IN POROUS ELECTRODE**
Oscar Lanzi and Uziel Landau *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 305-31 (For primary document see N87-29914 24-44)
Avail: NTIS HC A16/MF A01 CSCL 10C

Porous electrodes generally contain constricted macropores and localized micropores. The effects of the macropore constrictions on the resistance of a capillary were studied and an analytical model was developed for predicting the current distribution in a constricted macropore which directly includes constriction effects and does not require an empirical tortuosity parameter. The current and concentration distributions in localized micropores were also investigated and it was shown that the microporous area is fully accessible to charge and mass transfer processes. From these analyses it was concluded that the micropores primarily affect the kinetics of the interfacial processes by contributing to the interfacial area, while the macropores impose ohmic and mass transport limitations through the volume of the porous electrode. Author

**N87-29945*#** Case Western Reserve Univ., Cleveland, Ohio. Dept. of Chemical Engineering.
**THEORETICAL PERFORMANCE OF HYDROGEN-BROMINE RECHARGEABLE SPE FUEL CELL**
Robert F. Savinell and S. D. Fritts *In* NASA-Lewis Research Center, Space Electrochemical Research and Technology (SERT) Sep. 1987 p 321-34 (For primary document see N87-29914 24-44)
(Grants NAG3-500; NSF CPE-83-51849)
Avail: NTIS HC A16/MF A01 CSCL 10C

A mathematical model was formulated to describe the performance of a hydrogen-bromine fuel cell. Porous electrode theory was applied to the carbon felt flow-by electrode and was coupled to theory describing the solid polymer electrolyte (SPE) system. Parametric studies using the numerical solution to this model were performed to determine the effect of kinetic, mass transfer, and design parameters on the performance of the fuel cell. The results indicate that the cell performance is most sensitive to the transport properties of the SPE membrane. The model was also shown to be a useful tool for scale-up studies. Author

**N87-29946#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.
**LIFTING SURFACE PERFORMANCE ANALYSIS FOR HORIZONTAL AXIS WIND TURBINES**
D. Kocurek Jun. 1987 312 p
(Contract DE-AC02-83CH-10093)
(DE87-001176; SERI/STR-217-3163) Avail: NTIS HC A14/MF A01

This report describes how numerical lifting-surface theory is applied to the calculation of a horizontal-axis wind turbine's aerodynamic characteristics and performance. The report also describes how such an application is implemented as a computer program. The method evolved from rotary-wing and helicopter applications and features a detailed, prescribed wake. The wake model extends from a hovering-rotor experimental generalization to include the effect of the windmill brake state on the radial and axial displacement rates of the trailing vortex system. Performance calculations are made by coupling the lifting-surface circulation solution to a blade-element analysis that incorporates two-dimensional airfoil characteristics as functions of angle of attack and Reynolds number. Several analytical stall models are also provided to extend the airfoil characteristics beyond the limits of available data. Although this work focuses on the steady-performance problem, the method includes ways to investigate the effects of wind-shear profile, tower shadow, and off-axis shaft alignment. Correlating the method to measured wind-turbine performance, and comparing it to blade-element momentum theory calculations, validate and highlight the extreme sensitivity of predictions to the quality of early post-stall airfoil behavior. DOE

**N87-29947#** Research Triangle Inst., Research Triangle Park, N.C.

**A HIGH-EFFICIENCY, SINGLE-JUNCTION, BACK-SURFACE GaAs CONCENTRATOR SOLAR CELL Annual Subcontract Report, 1 Feb. 1985 - 30 Apr. 1986**

M. F. Lamorte May 1987 95 p Prepared in cooperation with Midwest Research Inst., Golden, Colo.

(Contract DE-AC02-83CH-10093)

(DE87-001178; SERI/STR-211-3033) Avail: NTIS HC A05/MF A01

The goals of Phase I of this research program were to determine the performance potential and technological feasibility of the Al/sub x/Ga/sub 1-x/As-GaAs back-surface, point-contact concentrator solar cell. The scope of the work required that the goals would be achieved by applying an analytical model, a corresponding computer simulation, and thorough preliminary material growth and cell fabrication. The computer simulation provided realistic, quantitative projections of cell performance. Epitaxial growth and device fabrication demonstrated the technological feasibility of the structure and identified key issues to be resolved in Phase II. Computer modeling results are presented. An optimized cell design and performance characteristics of similar cell designs were investigated. The optimum value of each parameter was obtained by allowing only that parameter to vary over a selected range and then determining the value at maximum efficiency. Simulation results showed that 30% efficiency may be obtained under operational conditions of solar concentrations of 10 suns and 300 K. DOE

**N87-29948#** Department of Energy, Portland, Oreg.

**THE WORLD'S FIRST MULTI-MEGAWATT WIND FARM: CONSTRUCTION OF THE MOD-2 WIND TURBINE GENERATORS AT THE GOODNOE HILLS, WASHINGTON TO EVALUATE A NEW SOURCE OF RENEWABLE ENERGY**

Aug. 1986 28 p

(DE87-001327; DOE/BP-653) Avail: NTIS HC A03/MF A01

The three MOD-2 wind turbines at the Goodnoe Hills near Goldendale, Washington, make up the first multi-megawatt electric power wind farm in the world. They are part of a great experiment, which, if it succeeds, may launch a new age of wind power development. The MOD-2 is a research and development project with considerable research costs and one-of-a-kind construction costs in its budget. It does not generate power as cheaply as a coal or nuclear plant, but future wind turbines based on the MOD-2 design or similar designs may. The success of the MOD-2 design will help realize the goal of cost-competitive power generation from the wind. This booklet reviews some of the events which brought the MOD-2 installation at the Goodnoe Hills into being, and briefly describes the components of the wind machines and elements of the research test program. DOE

**N87-29949#** Vachon (William A.) and Associates, Inc., Manchester, Mass.

**A DESIGN CODE TO STUDY VERTICAL-AXIS WIND TURBINE CONTROL STRATEGIES**

William A. Vachon Jul. 1987 33 p Prepared in cooperation with Sandia National Labs., Albuquerque, N. Mex.

(Contract DE-AC04-76DP-00789)

(DE87-012499; SAND-87-7012) Avail: NTIS HC A03/MF A01

A computer code called ASYM is described. The code permits a wind turbine designer to examine the role of low and high wind speed cut-in and cutout control strategies on the production of energy and the consumption of fatigue life by a wind turbine. The primary goal of the code development has been to create a design tool to optimize the energy production and the fatigue life of a wind machine through optimized high wind speed control schemes. The code is also very useful in evaluating start-up algorithms. It works primarily in the time domain and simulates high-frequency random wind of specific statistical characteristics while employing energy and damage density functions to calculate the results. A modified net present value calculation of the annual machine revenues and costs over the calculated life of the wind turbine is used to compare the merits of various control algorithms. Typical results are provided to demonstrate the use of the code. DOE

**N87-29950#** Sandia National Labs., Albuquerque, N. Mex.

**SOLAR KINETICS, INCORPORATED, MODULAR INDUSTRIAL SOLAR RETROFIT QUALIFICATION TEST RESULTS**

C. P. Cameron and V. E. Dudley Apr. 1987 85 p Prepared in cooperation with Edgerton, Germeshausen and Grier, Inc., Albuquerque, N. Mex.

(Contract DE-AC04-76DP-00789)

(DE87-012516; SAND-85-2320-Rev) Avail: NTIS HC A04/MF A01

Under the Department of Energy's Modular Industrial Solar Retrofit project, industrial process steam systems incorporating line-focus solar thermal collectors were designed and hardware was installed and tested. This report describes the test results for the system designed by Solar Kinetics, Incorporated. The test series included function and safety tests to determine that the system operated as specified, an unattended operations test to demonstrate automatic operation, performance tests to provide a database for predicting system performance, and life cycle tests to evaluate component and maintenance requirements. Component-level modifications to improve system performance and reliability were also evaluated. DOE

**N87-29951#** Los Alamos National Lab., N. Mex.

**FUEL CELLS FOR EXTRATERRESTRIAL AND TERRESTRIAL APPLICATIONS**

S. Srinivasan 1987 32 p Presented at the 171st Electrochemical Society Meeting, Philadelphia, Pa., 10 May 1987

(Contract W-7405-eng-36)

(DE87-013160; LA-UR-87-2393; CONF-870560-3) Avail: NTIS HC A03/MF A01

The fuel cell is a nineteenth century invention and a twentieth century technology development. Due to the high power and energy density, high efficiency, reliability, and production of pure water, hydrogen-oxygen fuel cell systems have no competition as auxiliary power sources for space vehicles. The alkaline fuel cell system is a well developed and proven technology for this application. The solid polymer electrolyte system may be its future competitor. The energy crisis of 1973 stimulated research, development and demonstration of the phosphoric acid, molten carbonate, solid oxide and solid polymer electrolyte fuel cell systems using natural gas, petroleum or coal derived hydrogen (and carbon monoxide for the high temperature systems) for terrestrial applications. The direct methanol-air fuel cell is still an electrochemist's dream. Though considerable technological advances have been made, the present price of crude oil, and the high capital costs and limited lifetime of fuel cell systems impede their terrestrial applications in the developed countries. Conversely, the potential for lower capital costs of labor intensive manufacturing processes and the relatively higher fossil fuel prices make these systems more attractive for such applications in the developing countries. DOE

**N87-29952#** Sandia National Labs., Albuquerque, N. Mex.

**THE LIFE COMPUTER CODE: FATIGUE LIFE PREDICTION FOR VERTICAL AXIS WIND TURBINE COMPONENTS**

H. J. Sutherland, T. D. Ashwill, and N. Slack Aug. 1987 69 p

(Contract DE-AC04-76DP-00789)

(DE87-013400; SAND-87-0792) Avail: NTIS HC A04/MF A01

The LIFE computer code was originally written by Veers to analyze the fatigue life of a vertical axis wind turbine (VAWT) blade. The basic assumptions built into this analysis tool are: the fatigue life of a blade component is independent of the mean stress; the frequency distribution of the vibratory stresses may be described adequately by a Rayleigh probability density function; and damage accumulates linearly (Miner's Rule). Further, the yearly distribution of wind is assumed to follow a Rayleigh distribution. The original program has been updated to run in an interactive mode on a personal computer with a BASIC interpreter and 256K RAM. Additional capabilities included in this update include: the generalization of the Rayleigh function for the wind speed distribution to a Weibull function; the addition of two constitutive

rules for the evaluation of the effects of mean stress on fatigue life; interactive data input; and the inclusion of a stress concentration factor into the analysis. DOE

**N87-29953#** Case Western Reserve Univ., Cleveland, Ohio. Dept. of Physics.
**EFFECT OF PHYSICAL AND GEOMETRIC FACTORS ON THE IMPEDANCE OF ELECTROCHEMICAL POWER SOURCES Interim Report**
B.D. Cahan, M. L. Daroux, and E. B. Yeager 1 May 1987 27 p
(Contract N00014-86-C-0808)
(AD-A183026; TR-1) Avail: NTIS HC A03/MF A01 CSCL 10B

Short-time transient behavior in the charge/discharge of small electrochemical power sources does not scale up for large systems. Calculations are presented which show that a number of commonly neglected physical and geometric factors, such as the skin effect and the distributed network impedance characteristics of the individual cells and cell assemblies, can severely limit performance. The impedance of individual cells has been calculated over a wide range of frequencies 100-10th to the 8th Hz using a modified semi-infinite strip-line model. The variables considered include the electrode and electrolyte conductivities, the electrolyte dielectric constant, the double-layer capacitance, and the distributed inductance and capacitance resulting from the cell geometry. GRA

**N87-29954#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**HIGH-EFFICIENCY SILICON SOLAR CELL (SELECTED PORTIONS)**
Jiqun Shi 22 Jul. 1987 9 p Transl. into ENGLISH from Huazhong Gongxueyuan Xuebao (Communist China), no. 4, 1984 p 67-69, 72
(AD-A183039; FTD-ID(RS)T-1056-86) Avail: NTIS HC A02/MF A01 CSCL 10B

Our research work on high-efficiency silicon solar cells first of all began with raising circuit voltage as well as assisting with certain measures to improve short circuit current density and fill factor. The cells which were developed had their total surface area efficiency measured at 18.7% in evaluation tests at the Solar Research Institute in Colorado. This is the highest value obtained by a silicon cell measured at this institute. It is a relatively large improvement compared to the efficiency of silicon cells measured by similar methods previously published. As a result of using such measures as surface passivation technology, circuit voltage has been increased. As a result of high circuit voltage and low series resistance extremely high fill factors have been achieved. As a result of employing designs such as double layer, anti-reflective film and decreasing electrode shading area, short circuit current density has been increased. GRA

**N87-29955#** State Univ. of New York, Buffalo. Dept. of Electrical and Computer Engineering.
**ELECTRON IRRADIATION EFFECTS ON THE SHUNT RESISTANCE OF SILICON SOLAR CELLS Technical Report, 1 Aug. 1986 - 31 Jul. 1987**
Sonali Banderjee and Wayne A. Anderson 31 Jul. 1987 10 p
(Contract N00014-86-K-0622)
(AD-A183378; TR-6) Avail: NTIS HC A02/MF A01 CSCL 10B

Shunt resistance Rsh values greater than 5 X 10 to the 6th power ohms have been measured for high efficiency silicon solar cells fabricated by a low temperature diffusion technique, whereas lower values ((0.5-.0)x100,000ohms) were obtained for ion-implanted solar cells. A degradation in Rsh values by an order of magnitude was observed after electron irradiations of 1 MeV to a fluence of 1 X 10th to the 16th power e/sq.cm. Temperature dependence studies indicated a rapid decrease in Rsh above a threshold temperature which is sensitive to the device quality. As the fluence of irradiation increased, very little shift in the threshold temperature towards lower values was observed. The degradation in Rsh causes an enhancement in the dark saturation current which is partly responsible for degradation in the open-circuit voltage of the devices. GRA

**N87-29956*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PERFORMANCE AND POWER REGULATION CHARACTERISTICS OF TWO AILERON-CONTROLLED ROTORS AND A PITCHABLE TIP-CONTROLLED ROTOR ON THE MOD-O TURBINE Final Report**
Robert D. Corrigan, Clinton B. F. Ensworth, III, and Dean R. Miller Oct. 1987 21 p
(Contract DE-AI01-76ET-20320)
(NASA-TM-100136; DOE/NASA/20320-73; E-3686; NAS 1.15:100136) Avail: NTIS HC A02/MF A01 CSCL 10B

Tests were conducted on the DOE/NASA mod-0 horizontal axis wind turbine to compare and evaluate the performance and the power regulation characteristics of two aileron-controlled rotors and a pitchable tip-controlled rotor. The two aileron-controlled rotor configurations used 20 and 38 percent chord ailerons, while the tip-controlled rotor had a pitchable blade tip. The ability of the control surfaces to regulate power was determined by measuring the change in power caused by an incremental change in the deflection angle of the control surface. The data shows that the change in power per degree of deflection angle for the tip-controlled rotor was four times the corresponding value for the 2- percent chord ailerons. The root mean square power deviation about a power setpoint was highest for the 20 percent chord aileron, and lowest for the 38 percent chord aileron. Author

**N87-29957*#** Illinois Univ., Urbana-Champaign.
**COMPUTER MODELLING OF ALUMINUM-GALLIUM ARSENIDE/GALLIUM ARSENIDE MULTILAYER PHOTOVOLTAICS M.S. Thesis**
Michael Broderick Wagner 1987 39 p
(Grant NAG3-507)
(NASA-CR-181418; NAS 1.26:181418) Avail: NTIS HC A03/MF A01 CSCL 10A

The modeled cascade cells offer an alternative to conventional series cascade designs that require a monolithic intercell ohmic contact. Selective electrodes provide a simple means of fabricating three-terminal devices, which can be configured in complementary pairs to circumvent the attendant losses and fabrication complexities of intercell ohmic contacts. Moreover, selective electrodes allow incorporation of additional layers in the upper subcell which can improve spectral response and increase radiation tolerance. Realistic simulations of such cells operating under one-sun AMO conditions show that the seven-layer structure is optimum from the standpoint of beginning-of-life efficiency and radiation tolerance. Projected efficiencies exceed 26 percent. Under higher concentration factors, it should be possible to achieve efficiencies beyond 30 percent. However, to simulate operation at high concentration will require a model for resistive losses. Overall, these devices appear to be a promising contender for future space applications. Author

**N87-29958*#** Illinois Univ., Urbana-Champaign. Dept. of Electrical and Computer Engineering.
**MODELLING OF MULTIJUNCTION CASCADE PHOTOVOLTAICS FOR SPACE APPLICATIONS M.S. Thesis, 1988**
James Louis Educato 1987 42 p
(Grant NAG3-507)
(NASA-CR-181417; NAS 1.26:181417) Avail: NTIS HC A03/MF A01 CSCL 10A

An alternative class of photovoltaics was presented, which is designed to overcome two problem areas with conventional cascade designs: poor upper subcell performance and lossy intercell ohmic contact (IOC). It was shown that upper subcell quality can be improved by incorporating additional junctions into the upper subcell and that the problems with monolithic IOCs may be circumvented by using complementary pairs of three-terminal cells or a 1 x 2 voltage-matched configuration. Realistic simulations show that AlGaAs-GaAs and AlGaAs-InGaAs

multijunction, multiband-gap solar cells (MJSC) may achieve benginning-of-life (BOL) one-sun, AMO efficiencies of 26 and 28 percent, respectively. Complementary cells made in the AlGaAs-InGaAs system can achieve BOL one-sun AMO efficiencies in excess of 27 percent. Seven-layer MJSCs are most advantageous for space applications due to their superior tolerance to radiation degradation. Author

# 45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

**N87-29959#** Oak Ridge National Lab., Tenn.
**ENVIRONMENTAL CONSEQUENCES OF CO2-CLIMATE INTERACTIONS: THE NEED FOR INTEGRATED PESOURCE ANALYSIS**
R. M. Cushman, J. C. Waterhouse, and M. P. Farrell 21 Jun. 1987 17 p Presented at the 80th Annual Meeting of the Air Pollution Control Association, New York, N.Y., 1 Jun. 1987
(Contract DE-AC05-84OR-21400)
(DE87-011119; CONF-870695-5) Avail: NTIS HC A02/MF A01

The paper reviews various studies dealing with the results of the increasing atmospheric carbon dioxide concentration and the climatic change it will cause. The writer recommends the construction of integrated regional resource analysis models to fully understand the consequences of the CO2 increase. DOE

**N87-29960#** Oregon State Univ., Corvallis. Inst. of Oceanography.
**DETECTING CHANGES IN GLOBAL CLIMATE INDUCED BY GREENHOUSE GASES**
T. P. Barnett and M. E. Schlesinger 12 May 1987 26 p Prepared in cooperation with Scripps Institution of Oceanography, La Jolla, Calif. and Lawrence Livermore National Lab., Calif.
(Contract W-7405-eng-48)
(DE87-012905; UCRL-15919) Avail: NTIS HC A03/MF A01

A quantitative search for a theoretically predicted CO2 signal in surface air temperature data extending back to 1899 was marginally successful in a statistical sense. However, the nature of the signal-strength time series suggested this result in an artifact of large-scale decadal variations at the beginning and end of the record. Application of the fingerprint strategy to three different global fields of climate variables over the last 25 to 35 years showed no significant CO2 signal. The analysis pointed up the need to use: (1) model S/N ratios in selecting fields for subsequent analysis, and (2) multiple fields in the detection process. Most important, we found the primary pattern of natural air temperature variability to be very similar to the expected CO2 signal, thus suggesting the air temperature field is not the best place to attempt early detection of the CO2 signal. By contrast, the primary pattern of natural variability and expected CO2 signals in the ocean's surface temperature is substantially different suggesting the oceans as a low-noise environment in which to attempt early detection. DOE

# 46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

**N87-29961*#** Lunar and Planetary Inst., Houston, Tex.
**WORKSHOP ON TECHTONIC EVOLUTION OF GREENSTONE BELTS**
M. J. deWit, ed. and Lewis D. Ashwal, ed. Jan. 1986 234 p Workshop held in Houston, Tex., 16-18 Jan. 1986
(Contract NASw-4066)
(NASA-CR-180544; NAS 1.26:180544; LPI-TR-86-10) Avail: NTIS HC A11/MF A01 CSCL 08G

Topics addressed include: greenstone belt externalities; boundaries; rock terranes; synthesis and destiny; tectonic evolution; rock components and structure; sedimentology; stratigraphy; volcanism; metamorphism; and geophysics. B.G.

**N87-29962#** Los Alamos National Lab., N. Mex.
**OBSERVATIONS OF PROLONGED IONOSPHERIC ANOMALIES FOLLOWING PASSAGE OF AN INFRASOUND PULSE THROUGH THE LOWER THERMOSPHERE**
A. R. Jacobson and R. C. Carlos Jun. 1987 19 p
(Contract W-7405-eng-36)
(DE87-012706; LA-10986-MS) Avail: NTIS HC A02/MF A01

We have studied the Doppler spectra of E-layer vertical-incidence HF soundings around the time of passage of a brief (duration approx. 10 s) acoustic shock. Following the exit of the shock from the reflection volume, there occurred a several-minute episode of spectral derangement. We have analyzed this derangement in some detail and have related it to other studies of possibly the same phenomenon. DOE

**N87-29963#** National Oceanic and Atmospheric Administration, Washington, D. C. National Environmental Satellite, Data and Information Service.
**DATA PROCESSING ALGORITHMS FOR INFERRING STRATOSPHERIC GAS CONCENTRATIONS FROM BALLOON-BASED SOLAR OCCULTATION DATA**
I. L. Chang Apr. 1987 38 p Prepared in cooperation with American Univ., Washington, D. C.
(PB87-196424; NOAA-TM-NESDIS-31) Avail: NTIS HC A03/MF A01 CSCL 04A

In three high-altitude balloon experiments, concentrations of ozone, water vapor, and other gases in the stratosphere were inferred, using the technique of solar occultation. The objective was to demonstrate feasibility of a new technique before implementing it on a satellite, and to gain experience with handling the data. The technical report documents in detail the methods developed for processing the data. It presents the equations that describe the atmospheric physics of the measurement and the algorithm to solve them. It also presents practical aspects of applying the algorithms to real data, methods for overcoming aberrations and problems inherent in the occultation technique, and sample results. GRA

**N87-29964#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**X-RAY FLUXES IN THE ATMOSPHERE**
Osmar Pinto, Jr. and Walter D. GonzalezAlarcon Aug. 1985 10 p In PORTUGUESE; ENGLISH summary
(DE87-702803; INPE-3604) Avail: NTIS (US Sales Only) HC A02/MF A01

A short review of X-ray measurements in the atmosphere is presented. In this context, the measurements obtained with NaI (T1) scintillation detectors on board stratospheric balloons launched from Sao Jose dos Campos, Brazil in 1981, are considered as a first evidence of X-rays related to natural electron precipitation at the South Atlantic Magnetic Anomaly. Finally, a comparison of the related fluxes with those due to other sources, at balloon altitudes and at energies around 50 KeV, is also given. DOE

**N87-29965#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.
**INVESTIGATION OF A CLOUD-COVER MODIFICATION TO SPCTRAL2, SERI'S SIMPLE MODEL FOR CLOUDLESS-SKY, SPECTRAL SOLAR IRRADIANCE**
R. E. Bird, C. J. Riordan, and D. R. Myers Jun. 1987 37 p
(Contract DE-AC02-83CH-10093)
(DE87-001177; SERI/TR-215-3038) Avail: NTIS HC A03/MF A01

This report summarizes the investigation of a cloud-cover modification to SPCTRAL2, SERI's simple model for cloudless-sky, spectral solar irradiance. The approach was to develop a modifier that relies on commonly acquired meteorological and broadband-irradiance data rather than detailed cloud properties

that are generally not available. The method was to normalize modeled, cloudless-sky spectral irradiance to a measured broadband-irradiance value under cloudy skies, and then to compare the normalized, modeled data with measured spectral-irradiance data to empirically derive spectral modifiers that improve the agreement between modeled and measured data. Results indicate the possible form of the spectral corrections; however, additional data must be analyzed to develop a spectral transmission function for cloudy-sky conditions. DOE

**N87-29966#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

**EXTRATERRESTRIAL SPECTRAL SOLAR IRRADIANCE DATA FOR MODELING SPECTRAL SOLAR IRRADIANCE AT THE EARTH'S SURFACE**

C. Riordan May 1987 41 p

(Contract DE-AC02-83CH-10093)

(DE87-001179; SERI/TR-215-2921) Avail: NTIS HC A03/MF A01

This report describes the extraterrestrial (air mass zero, AMO) spectral solar irradiance data used by the Solar Energy Research Institute's Resource Assessment Branch in models to calculate spectral solar irradiance at the Earth's surface. The report contains tables and graphs of the AMO spectrum updated by the World Radiation Center in Daveos, Switzerland, in 1985. DOE

**N87-29967*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**AN IMPROVED MODEL OF THE EARTH'S GRAVITATIONAL FIELD: GEM-T1**

J. G. Marsh, F. J. Lerch, D. C. Christodoulidis, B. H. Putney, T. L. Felsentreger, B. V. Sanchez, D. E. Smith, S. M. Klosko, T. V. Martin, and E. C. Pavlis Jul. 1987 351 p Prepared in cooperation with EG and G Washington Analytical Services Center, Inc., Lanham, Md. and SAR, Inc., Lanham, Md.

(NASA-TM-4019; Rept-87B0451; NAS 1.15:4019) Avail: NTIS HC A16/MF A01 CSCL 08G

Goddard Earth Model T1 (GEM-T1), which was developed from an analysis of direct satellite tracking observations, is the first in a new series of such models. GEM-T1 is complete to degree and order 36. It was developed using consistent reference parameters and extensive earth and ocean tidal models. It was simultaneously solved for gravitational and tidal terms, earth orientation parameters, and the orbital parameters of 580 individual satellite arcs. The solution used only satellite tracking data acquired on 17 different satellites and is predominantly based upon the precise laser data taken by third generation systems. In all, 800,000 observations were used. A major improvement in field accuracy was obtained. For marine geodetic applications, long wavelength geoidal modeling is twice as good as in earlier satellite-only GEM models. Orbit determination accuracy has also been substantially advanced over a wide range of satellites that have been tested. Author

**N87-29968** Deutsche Geodaetische Kommission, Munich (West Germany).

**THE GERMAN GEODETIC INVESTIGATIONS IN THE FRAMEWORK OF THE INTERNATIONAL GLACIOLOGICAL GREENLAND EXPEDITION (EGIG) 1959-1974 [DIE DEUTSCHEN GEODAETISCHEN ARBEITEN IN RAHMEN DER INTERNATIONALEN GLAZIOLOGISCHEN GROENLAND-EXPEDITION (EGIG) 1959-1974]**

1986 84 p In GERMAN

(Ser-B-281; ISBN-3-7696-8566-0; ISSN-0065-5317; ETN-87-90355) Copyright Avail: Issuing Activity

Geodesy and the investigation of decimeter wave propagation over snow planes are discussed. Geomagnetic variations in polar regions were studied. The drift of the inland ice of Greenland was investigated. Measurements were performed on the West-East profile. For individual titles, see N87-29969 through N87-29972.

**N87-29969** Deutsche Geodaetische Kommission, Munich (West Germany).

**THE 1967 MEASURING CAMPAIGN OF THE GROUP GEODESY A [DIE MESSKAMPAGNE 1967 DER GRUPPE GEODAESIE A]**

Klemens Nottarp and Achim Karsten *In its* The German Geodetic Investigations in the Framework of the International Glaciological Greenland Expedition (EGIG) 1959-1974 1986 p 7-30 In GERMAN (For primary document see N87-29968 24-46)

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The propagation of decimeter waves over snow planes was studied. The dosed traverse in the East-West profile between Cecilia Nuratak (Greenland) and Camp4-EGIG was measured. Special geodetic measurements were performed in the East-West profile. The dosed traverse Carrefour-T132 was measured in the North-South profile. Temperature gradients in the range between 0 and 3 m above the plane, and the dielectric properties of snow were measured. Simultaneous time-of-flight measurements at several heights above the snow were conducted in order to elucidate the effect of the soil on the wave propagation. ESA

**N87-29970** Deutsche Geodaetische Kommission, Munich (West Germany).

**MAGNETIC DIRECTION MEASUREMENT [MAGNETISCHE RICHTUNGSMESSUNGEN]**

Franz-Josef Heimes *In its* The German Geodetic Investigations in the Framework of the International Glaciological Greenland Expedition (EGIG) 1959-1974 1986 p 31-41 In GERMAN (For primary document see N87-29968 24-46)

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Fluctuations of the Earth magnetic field in polar regions were measured. Permanent observations were made in different locations in 1967 and 1968, leading to the understanding of the daily periodical as well as the irregular variations of the magnetic declination on the inland ice of Greenland. Magnetic azimuths were measured, and declination values were deduced from a comparison between geodetic and magnetic azimuth along the East-West profile. ESA

**N87-29971** Deutsche Geodaetische Kommission, Munich (West Germany).

**DRIFT OF THE INLAND ICE IN THE WEST-EAST PROFILE FROM 1959 TO 1967 [BEWEGUNG DES INLANDEISES IM WEST-OST-PROFIL VON 1959 BIS 1967]**

Walther Hoffmann *In its* The German Geodetic Investigations in the Framework of the International Glaciological Greenland Expedition (EGIG) 1959-1974 1986 p 43-61 In GERMAN (For primary document see N87-29968 24-46)

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The flow motion of the inland ice of Greenland was investigated, on the basis of geodetic measurements during the summer campaigns 1959 and 1967. The polygon elements 1959 and 1967 are discussed. The closed traverse and the displacement vectors were calculated, and the errors determined. The results led to the determination of the flow motion for different latitudes and height, in a representative cross section from coast to coast. ESA

**N87-29972** Deutsche Geodaetische Kommission, Munich (West Germany).

**THE INTERMEDIATE COMPAIGN 1974 [DIE ZWISCHENKAMPAGNE 1974]**

Manfred Stober *In its* The German Geodetic Investigations in the Framework of the International Glaciological Greenland Expedition (EGIG) 1959-1974 1986 p 63-84 In GERMAN (For primary document see N87-29968 24-46)

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Geodetic and geophysical measuring campaigns in Greenland were conducted. The extension, inclination, and snow heights of the West-East profile were determined. Deformation figures were analyzed. Refraction studies and zenith distance measurements were made. Gravimetric measurements were performed for the investigation of the Bouguer anomaly. ESA

**N87-29973#** Pennsylvania State Univ., University Park. Dept. of Meteorology.
**SUM RULES FOR OPTICAL EXTINCTION AND SCATTERING BY SMALL PARTICLES Final Report, 16 May 1984 - 15 May 1986**
Craig F. Bohren 10 Aug. 1986 16 p
(Grant AF-AFOSR-0145-84)
(AD-A182947; AFOSR-87-0873TR) Avail: NTIS HC A02/MF A01 CSCL 04A

The sum rule for extinction is not changed when magnetic dipole as well as electric dipole ration is considered. Moreover, the limitation of electron mean free paths in metallic particles does not invalidate sum rules. When metallic particles are sufficiently small, the effect of their boundaries is to decrease peak extinction while simultaneously broadening it in such a way that integrated extinction remains constant. GRA

**N87-29974#** Pennsylvania State Univ., University Park.
**CALCULATION OF SOURCE AND STRUCTURAL PARAMETERS AT REGIONAL AND TELESEISMIC DISTANCES Final Technical Report, 2 Jan. 1985 - 2 Jan. 1987**
Charles A. Langston 28 Feb. 1987 325 p
(Contracts F19628-85-K-0010; ARPA Order 5299; AF Proj. 5A10)
(AD-A183008; AFGL-TR-87-0066) Avail: NTIS HC A14/MF A01 CSCL 08K

Wave number integration and generalized ray theory methods for computation of synthetic seismograms have been used to model short-period local and near regional seismograms from small (M1 2.5 - 4.0) earthquakes located in Australia and India. When the effect of crustal structure is adequately known, source depth can be determined with an accuracy of 1 km or less from sP and Rg wave arrivals within the observed wave forms. The determination of source depth directly from the wave form data offers a method of discrimination of explosives from earthquakes using sparse station distribution since it is unlikely that explosions will be emplaced below depths of a few kilometers. A method for computing the wavefield for SH and P-SV line sources in an elastic layer-over-halfspace model with corrugated boundaries has been developed to study the effect of imperfections in a crustal waveguide. The formulation allows the computation of the wave field at any point within the model. The formulation is appropriate for the study of scattered high frequency crustal phases such as Pg and Lg and mantle phases such as Pn and Sn. Source parameters of selected earthquakes have been obtained from inversion of teleseismic body wave data for use in regional wave propagation studies. Upper mantle structure was examined using P waves from an intermediate depth earthquake under Hispaniola. GRA

**N87-29975#** Pittsburgh Univ., Pa.
**ENERGY TRANSFER PROCESSES OF IMPORTANT ATMOSPHERIC SPECIES Final Report, 1 Nov. 1983 - 31 Oct. 1986**
Joseph M. Thomas 11 Feb. 1987 33 p
(Contract F19628-84-K-0048)
(AD-A183042; AFGL-TR-87-0117) Avail: NTIS HC A03/MF A01 CSCL 07D

Recent work in our laboratory has concentrated on the kinetics of metastable molecular nitrogen, N2(A 3 sigma (+) sub u). Investigations have included measuring v-level specific bimolecular rate constants for the reactions of N2(A, less than or = 6) with relatively efficient electronic quenchers (02, NO, CO, N2O, and C2H4) and inefficient electronic quenchers (CH4 and CF4). The latter set of quenchers has provided information on the relative N2(A, v) population distribution in the discharge flow reactor for various N2(A 3 sigma (+) sub u) generating reactions and N2 concentrations. In addition, v-level specific rate constants are measured for the reaction N2(A v less than or = 3) + O(3P) and measured the absolute nitric oxide product yield in the reaction N2(A) + O2/O(3P) as a function of the relative N2(A, v) population distribution using calibrated NO LEF. GRA

**N87-29976#** Regis Coll., Weston, Mass.
**LARGE-SCALE PLASMA DENSITY FLUCTUATIONS MEASURED WITH THE HILAT SATELLITE AT 830 km ALTITUDE**
Daniel R. Weimer 1 Apr. 1987 54 p
(Contract F19628-86-K-0045)
(AD-A183043; AFGL-TR-87-0110; SR-2) Avail: NTIS HC A04/MF A01 CSCL 04A

Measurements from the plasma monitor on the HILAT satellite have been used to map the distribution of large scale fluctuations in the density of plasma at high latitudes. Digital filtering has been used to separate the original data into three frequency bands. The output from the middle band pass filter has been used to count and map the distribution of large-scale plasma density enhancements. Maps of blob distribution are drawn as a function of magnetic local time and invariant latitude, for both low and high magnetic activity. To serve as a point of reference the same filtering and counting techniques are applied to measurements of the ion drift velocity to show the distribution of electric field fluctuations. Additionally, from the power levels measured at two different frequencies, the average spectral slopes of both the plasma density and electric field have been mapped. The results show that large scale plasma enhancements are created in the auroral zone and are transported away from the production regions by convection. Movement of blobs from the cusp to polar cap is very prominent. The spectral slope of the plasma density is significantly increased in the night side, from 23 to 2 hour magnetic local time. The intermediate scale plasma irregularities appear to be dissipated in this region. Enhanced radio scintillations had been measured with the HILAT radio beacon in the same locations. GRA

**N87-29977#** Northwest Research Associates, Inc., Bellevue, Wash.
**A MID-LATITUDE SCINTILLATION MODEL Technical Report, 1 Nov. 1985 - 31 Oct. 1986**
Robert E. Robins, James A. Secan, and E. J. Fremouw 31 Oct. 1986 75 p
(Contract DNA001-85-C-0017)
(AD-A183143; NWRA-86-R004; DNA-TR-86-381) Avail: NTIS HC A04/MF A01 CSCL 04A

Radiowave scintillation in the presence of ionospheric disturbances has the potential to disrupt numerous transionospheric radio and radar systems. This report describes development of a model characterizing the plasma density irregularities that produce scintillation in the naturally disturbed mid latitude F layer. The model will be incorporated into Program WBMOD, which includes subroutines for computing both link geometry and scintillation indices, the latter by means of phase screen diffraction theory. Earlier versions of WBMOD, were based on extensive analysis of scintillation data collected in the auroral and equatorial zones in Wideband Satellite Mission. The model described herein is based on similarly extensive analysis of Wideband data from one mid latitude station and of data collected from HiLat satellite at another mid latitude station. The model describes irregularities at an effective height of 350 km that are isotropic across the geomagnetic field and elongated by a factor of 10 along the field and whose one-dimensional spatial power spectrum obeys a single regime power law with a (negative) spectral index of 1.5. The height-integrated spectral strength of the irregularities is modeled as a function apex latitude of the point. The report highlights a disagreement by a factor of approximately three between irregularity strength inferred from the two satellites in a region of overlap between the two mid-latitude stations. GRA

**N87-29978#** Florida State Univ., Tallahassee. Mesoscale Air-Sea Interaction Group.
**A NUMERICAL STUDY ON THE INFLUENCE OF THE MID-ATLANTIC RIDGE ON NONLINEAR BAROTROPIC AND FIRST-MODE BAROCLINIC ROSSBY WAVES GENERATED BY SEASONAL WINDS M.S. Thesis**
Bernard Barnier Dec. 1986 158 p
(Contract N00014-85-G-0240)
(AD-A183260) Avail: NTIS HC A08/MF A01 CSCL 08C

A numerical model simulation investigates the influence of the mid-Atlantic ridge on nonlinear barotropic and first-mode baroclinic Rossby waves generated by seasonal wind fluctuations. The north Atlantic is simulated by a square-box, two-layered quasigeostrophic model. The bottom topography is ridgelike and compromises the QG approximation and the actual shape of the ridge. Sponge layers protect all boundaries except the eastern one from wave reflection. The model is forced by a purely fluctuating wind stress curl derived from the most significant EOF's of the FGGE winds. A flat bottom and a ridge experiment are compared. The topography is an important source of barotropic variability for the eastern basin. The topographic Rossby waves generated over the ridge, either by wave reflection or by direct wind forcing, account for at least 50% of the barotropic variability of that basin. In both experiments the eastern boundary is an important source of annual-period baroclinic Rossby waves. Wavetrains having a wavelength of about 1060 km and a westward phase speed around 3.4 cm/sec propagate energy westward at 3cm/sec. In the flat bottom experiment a source of directly wind forced baroclinic waves of annual period is found in the middle of the basin. Their amplitude is smaller and they have a noticeable northward phase propagation resulting in a southward group velocity component. The topography blocks the waves coming from the eastern boundary but generates new wave trains whose phase vector is almost normal to the ridge crest. GRA

**N87-29979#** SRI International Corp., Menlo Park, Calif.
**THE APPLICATION OF STATISTICAL TURBULENCE THEORY TO CONVECTIVE INSTABILITIES Technical Report, 13 Mar. 1985 - 30 Sep. 1986**
Charles L. Rino 1 Nov. 1986 32 p
(Contract DNA001-86-C-0002)
(AD-A183492; DNA-TR-86-402) Avail: NTIS HC A03/MF A01 CSCL 04A

Statistical turbulence theories have been used effectively to characterize spectral density functions in fluid turbulence, and in turbulent plasmas, magnetic fields, and passive scalars in turbulent fluids. This report reviews the applications to convective instabilities of the turbulence theories generalized for ionospheric applications. These instabilities are believed to be the dominant structuring mechanism in equatorial spread F, artificial barium clouds, and in high altitude nuclear plumes at late times. Emphasized is the ramifications of the cross field anisotropy unique to convective instabilities, which have not been treated previously. We show that the limiting form of the one-dimensional spectral density functions measured perpendicular to the E x B drift direction is proportional to i/k where k is the wave number. GRA

**N87-29980#** OptiMetrics, Inc., Burlington, Mass.
**SCRIBE (STRATOSPHERIC CRYOGENIC INTERFEROMETER BALLOON EXPERIMENT) DATA SURVEY AND VALIDATION Final Report, Jul. 1986 - Jan. 1987**
W. O. Gallery, D. L. Longtin, and G. Tucker 16 Feb. 1987 133 p
(Contract F19628-86-C-0182)
(AD-A183538; OMI-201; AFGL-TR-87-0061) Avail: NTIS HC A07/MF A01 CSCL 04A

The Stratospheric Cryogenic Interferometer Balloon Experiment (SCRIBE) is a 0.06/cm resolution infrared interferometer spectrometer measuring emission from a stratospheric balloon platform. Three successful operational flights so far have produced a significant body of data. Two different groups have processed the interferograms from two of these flights into calibrated spectra covering the region from 600/cm to 1200/cm and beyond. This report examines and critically evaluates these spectra in terms of the calibration and the presence of channel spectra of other modulation. The evaluation is based on model calculations and physical considerations which limit the expected range of the measured radiance. The result is a set of verified spectra which may be further analyzed for scientific information. Significant differences between the measured spectra and FASCODE calculations are reported. Recommendations are made for future flights. GRA

**N87-29981#** Naval Ocean Systems Center, San Diego, Calif.
**EVALUATION OF A DUAL-LIDAR METHOD FOR MEASURING AEROSOL EXTINCTION Final Report, Oct. 1986 - Mar. 1987**
M. R. Paulson Apr. 1987 65 p
(AD-A183550; NOSC/TD-1075) Avail: NTIS HC A04/MF A01 CSCL 07D

This report describes a method for determining aerosol distributions in the atmosphere using a technique that obtains extinction coefficient profiles and integrated extinction between two points. To implement this scheme, two lidars are set up at opposite ends of a propagation path and pointed toward each other. Since two equations are available to solve for the two unknowns, no assumptions are required concerning aerosol distributions. GRA

**N87-29982#** Air Force Geophysics Lab., Hanscom AFB, Mass.
**THEORETICAL ANALYSIS OF CHARGING DATA FROM ROCKET WITH CHARGED BEAM EMISSION: ENVIRONMENTAL RESEARCH PAPERS**
Charles W. Dubs 2 Oct. 1986 51 p
(AD-A183853; AFGL-TR-86-0209; AFGL-ERP-962) Avail: NTIS HC A04/MF A01 CSCL 20C

To gain physical understanding, an approximate analysis is made of charging data from the flight of a three conductor rocket at night in the lower F region of the ionosphere. Values of coefficients of potential, capacity, and induction are calculated, and a method of measuring them is given. Sheath radii are calculated. The extended probe is near the sheath's edge for 1 micro A, and inside the sheath for all other (larger) beam currents. The potential of the rear section is calculated; it is near zero, and is negative. The other potentials follow from measurements of potential differences. Probe theory is used to calculate the plasma-return current to the forward section and is found to account for the high negative values of potential measured for unsaturated beam currents. The 374 micro A and, especially, -10 mA beam-current cases are found to be highly saturated. Approximate formulae are developed to calculate the potential due to sheath charge. These, the coefficients, and the potentials give the conductor and sheath charges and the part of the conductor potentials due to the sheath. The charge on the forward section is nearly doubled due to the presence of the rear section. GRA

**N87-29983*#** New York Univ., New York. Inst. of Mathematical Sciences.
**AN ANALYSIS OF THE VERTICAL STRUCTURE EQUATION FOR ARBITRARY THERMAL PROFILES**
Stephen E. Cohn and Dick P. Dee Jun. 1987 61 p
(Grants NAG5-820; NAG5-341)
(NASA-CR-181397; NAS 1.26:181397) Avail: NTIS HC A04/MF A01 CSCL 04A

The vertical structure equation is a singular Sturm-Liouville problem whose eigenfunctions describe the vertical dependence of the normal modes of the primitive equations linearized about a given thermal profile. The eigenvalues give the equivalent depths of the modes. The spectrum of the vertical structure equation and the appropriateness of various upper boundary conditions, both for arbitrary thermal profiles were studied. The results depend critically upon whether or not the thermal profile is such that the basic state atmosphere is bounded. In the case of a bounded atmosphere it is shown that the spectrum is always totally discrete, regardless of details of the thermal profile. For the barotropic equivalent depth, which corresponds to the lowest eigen value, upper and lower bounds which depend only on the surface temperature and the atmosphere height were obtained. All eigenfunctions are bounded, but always have unbounded first derivatives. It was proved that the commonly invoked upper boundary condition that vertical velocity must vanish as pressure tends to zero, as well as a number of alternative conditions, is well posed. It was concluded that the vertical structure equation always has a totally discrete spectrum under the assumptions implicit in the primitive equations. Author

**N87-29984*#** Alabama Univ., Huntsville. Dept. of Physics.
**PLASMASPHERE AND MAGNETOSPHERE STRUCTURE FROM ISEE-1 AND DE-1 Final Report**
R. C. Olsen 15 Oct. 1987 31 p
(Grant NAG5-568)
(NASA-CR-181372; NAS 1.26:181372) Avail: NTIS HC A03/MF A01 CSCL 04A

The density structure of the plasmapause region was investigated using the two satellites, ISEE-1 and DE-1 to obtain complementary radial and latitudinal profiles. Data from the plasma wave receivers were to be used to obtain total electron density, and from the ion mass spectrometers to determine thermal plasma morphology. B.G.

**N87-29985*#** Georgia Inst. of Tech., Atlanta. School of Geophysical Sciences.
**IMPROVEMENTS IN THE PERTURBATION SIMULATIONS OF THE GLOBAL REFERENCE ATMOSPHERIC MODEL Semiannual Status Report, 23 Mar. - 22 Sep. 1987**
C. G. Justus, F. N. Alyea, and D. M. Cunnold Oct. 1987 19 p
(Grant NAG8-078)
(NASA-CR-181384; NAS 1.26:181384) Avail: NTIS HC A02/MF A01 CSCL 04A

The Global Reference Atmospheric Model (GRAM) program includes the capability for simulating pseudo-random perturbations in density, temperature, pressure, or wind components along a simulated reentry trajectory or other path through the atmosphere. Some concerns were expressed by GRAM users, however, that the mean-square perturbation gradients may be too large for small values of the vertical separation Delta z. The present GRAM perturbation simulations, based on a one-step autoregressive model, yield a power spectrum versus wavenumber k which is proportional to k sup -2 at high wavenumbers. This feature also produces mean-square perturbation differences which are directly proportional to Delta z, and mean-square perturbation gradients which are inversely proportional to Delta z. Thus, root-mean-square gradients, (Delta f/Delta z) sub rms, increase with decreasing Delta a as Delta z sup -1/2. A simple modification to GRAM is suggested which overcomes this problem, i.e., which produce root-mean-square gradient that remain bound as Delta z approaches zero. Possible applications of more sophisticated simulation approaches, e.g., second order autoregressive models, or fractal model techniques, were also explored briefly but found to yield improvements which appear too small to justify their considerable added complexity for use in the GRAM programs.
Author

**N87-29986** Southern Methodist Univ., Dallas, Tex.
**THERMOELASTIC LOADING AND RIFTING OF THE CONTINENTAL LITHOSPHERE Ph.D. Thesis**
Richard James McMullen, Jr. 1987 145 p
Avail: Univ. Microfilms Order No. DA8714389

A plane strain finite element is used to model the lithosphere adjacent to continental rifts as a constant and variable thickness elastic plate on a fluid foundation. The pre-rift lithosphere is modeled as a infinite continuous plate. A semi-infinite plate is used to characterize the rifted lithosphere. Thermal loading is produced by steady-state conduction from an infinite line source located at 60 km depth, beneath and parallel to the rift axis within the asthenosphere. Geometric nonlinearities occur because tension in the asthenosphere foundation scalar spring elements must be adjusted to compensate for vertical thermal expansion so that the foundation force is a function of the lithosphere surface vertical deflection. An iterative procedure is developed which adjusts foundation spring moduli after each solution to correct for this geometric nonlinearity. Lithosphere strength envelope curves derived from olivine flow laws are used to determine the elastic lithosphere depth in the variable thickness lithosphere solution. Thermoelastic loading may be the mechanism which initiates rift formation. Thermal loading may also be responsible for post-rift topography changes. Thermoelastic loading of the lithosphere is proposed as the driving mechanism for rift formation and development. Dissert. Abstr.

**N87-29556#** Joint Publications Research Service, Arlington, Va.
**COMPARISON OF SATELLITE MEASUREMENTS OF ELECTRICAL AND MAGNETIC FIELDS AND PARTICLE STREAMS WITH SURFACE GEOPHYSICAL DATA IN EARLY MORNING SECTOR OF AURORAL ZONE Abstract Only**
N. V. Isayev, A. G. Yakhnin, S. V. Bilichenko, T. N. Kolosova, V. I. Lazarev, R. Pellinen, N. Petkov, T. Stanev, M. V. Teltsov, and D. Teodosiyev et al. *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 40 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 74-85 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29559#** Joint Publications Research Service, Arlington, Va.
**OBSERVATIONS OF IONOSPHERIC TROUGH AT GREAT ALTITUDES USING PROGNOZ-5 SATELLITE Abstract Only**
V. P. Grigoryeva and V. V. Pisareva *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 43 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 103-109 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29560#** Joint Publications Research Service, Arlington, Va.
**MEASUREMENTS OF IONOSPHERIC ELECTRON TEMPERATURE USING LOW-FREQUENCY IMPEDANCE METER Abstract Only**
V. I. Aksenov, A. P. Modestov, and L. Yu. Sokolov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 44 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 110-117 Original language document was announced in IAA as A87-34217 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29565#** Joint Publications Research Service, Arlington, Va.
**ELECTRON KINETICS IN IONOSPHERIC D REGION UNDER CONDITIONS OF SIMULTANEOUS INCREASE IN IONIZATION LEVEL AND ELECTRON GAS TEMPERATURE Abstract Only**
S. I. Kozlov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 50 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 157-158 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29574#** Joint Publications Research Service, Arlington, Va.
**GEOMAGNETIC INTERSECTION OF TECTONIC STRUCTURES SEEN IN SPACE PHOTOGRAPHS Abstract Only**
M. I. Burleshin *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 111 Transl. into ENGLISH from Issledovaniye Zemli iz Kosmosa (Moscow, USSR), no. 6, Nov. - Dec. 1986 p 32-37 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

# 47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

**N87-29987*#** Chase Consulting, Inc., San Diego, Calif.
**PATTERN RECOGNITION OF SATELLITE CLOUD IMAGERY FOR IMPROVED WEATHER PREDICTION Final Report**
Catherine Gautier, Richard C. J. Somerville, and Leonid B. Volfson Sep. 1986 18 p
(Contract NAS5-29269)
(NASA-CR-180720; NAS 1.26:180720) Avail: NTIS HC A02/MF A01 CSCL 04B

The major accomplishment was the successful development of a method for extracting time derivative information from geostationary meteorological satellite imagery. This research is a proof-of-concept study which demonstrates the feasibility of using

pattern recognition techniques and a statistical cloud classification method to estimate time rate of change of large-scale meteorological fields from remote sensing data. The cloud classification methodology is based on typical shape function analysis of parameter sets characterizing the cloud fields. The three specific technical objectives, all of which were successfully achieved, are as follows: develop and test a cloud classification technique based on pattern recognition methods, suitable for the analysis of visible and infrared geostationary satellite VISSR imagery; develop and test a methodology for intercomparing successive images using the cloud classification technique, so as to obtain estimates of the time rate of change of meteorological fields; and implement this technique in a testbed system incorporating an interactive graphics terminal to determine the feasibility of extracting time derivative information suitable for comparison with numerical weather prediction products. Author

**N87-29988** ESDU International Ltd., London (England).
**COMPUTER PROGRAM FOR WIND SPEEDS AND LONGITUDINAL TURBULENCE INTENSITY. FLAT OR HILLY SITES IN TERRAIN WITH ROUGHNESS CHANGES**
Mar. 1985 15 p
(ESDU-85003; ISBN-0-85679-509-7; ISSN-0143-2702) Avail: ESDU

The program is extended which was presented in ESDU 84031, which predicts the effect of terrain roughness and height on wind speed, to output values of longitudinal turbulence intensity. Based on a wind model given in ESDU 82026 and 84045, a BASIC program is provided to calculate wind or gust speeds, for averaging times up to an hour, and the turbulence intensity at any height. The model applies to strong winds (exceeding 10 m/s or 22 miles/h) in temperate latitudes. The program allows up to 5 changes of terrain roughness upwind of the site and includes factors to take account of local topography such as hills, cliffs and escarpments. The program is interactive, prompting for input and allowing editing prior to execution. Guidance on the input is provided together with a worked example showing typical output. Tabulated values of wind or gust speeds and of longitudinal turbulence intensity for a single upwind roughness change are given respectively in ESDU 84011 and 84030. ESDU

**N87-29989#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**THE COMPOSITION OF PRECIPITATION IN CUBATAO REGION (S. PAULO, BRAZIL)**
Lycia Maria MoreiraNordemann, Olga Maria Danelon, Joao Ciarrochi Lopes, and Bruno Maset Filho Jul. 1987 31 p
(INPE-4263-PRE/1136) Avail: NTIS HC A03/MF A01

Cubatao is an industrial town, a home of twenty six industries discharging large quantities of gases and particles into the atmosphere, and solid and liquid wastes into the regional water flows. The geological and natural climatological characteristics of the region contribute to prevent the pollutants from being dispersed, the material injected into the atmosphere is thus concentrated in-loco. This injection of pollutants in the atmosphere also determines a modification in the chemical coposition of rain waters. High levels of chemical element contents were registered in the region, resulting from anthropogenic sources, even for natural species like Na(+), Ca(2+), K(+), and Mg. Other ions like SO4(2-), NO3(-), and NH3(4+) are present with extremely high concentrations. The SO4(2-) content in Cubatao rainwater is found to be higher than that found in Sao Paulo city, the biggest industrial center in South America. The rainwater did not show a tendency to acidity even when high levels of local pollution and high SO4(2-) and NO3(-) concentrations were observed. Author

**N87-29990#** Meteorological Satellite Center, Tokyo (Japan).
**METEOROLOGICAL SATELLITE CENTER TECHNICAL NOTE NO. 14, 1986**
Dec. 1986 80 p
(ISSN-0388-9653) Avail: NTIS HC A05/MF A01

Topics addressed include: geostationary satellite wind observations; statistical analyses of wind fields; precipitation intensity; extraction of infrared cloud-free radiance from image data; and GMS Space Environment Monitor (SEM) data. For individual titles, see N87-29991 through N87-29994.

**N87-29991#** Meteorological Satellite Center, Tokyo (Japan).
**IMPROVEMENTS IN GEOSTATIONARY SATELLITE WIND OBSERVATIONS AS A RESULT OF THE GLOBAL WEATHER EXPERIMENT (GWE) AND APPLICATIONS OF THESE IN THE CONTEXT OF THE WWW SYSTEM**
Tadaaki Hamada *In its* Meteorological Satellite Center Technical Note No. 14, 1986 Dec. 1986 p 1-28 Presented at the Conference on the Results of the Global Weather Experiment (GWE) and their Implications for the WWW, Geneva, Switzerland, 27-31 May 1985 (For primary document see N87-29990 24-47)
Avail: NTIS HC A05/MF A01

The history and present status of satellite wind observing systems are reviewed and summarized. Through the Global Weather Experiment (GWE) period (December 1, 1978 - November 30, 1979), cloud motion winds were routinely derived from 5 geostationary meteorological satellites by 4 operating agencies. The satellite winds agree well with conventional winds in most cases. The vector differences between satellite winds and radiosonde winds are 10 m/s or less for high level winds and 5 m/s or less for low-level winds. As a result of some improvements in operational wind derivation systems, the satellite wind observation was stabilized in quality among the operating agencies. The applicability of the satellite wind derivation system is discussed. As the satellite winds have global coverage and as it is easy to handle them with computers, satellite winds data are very useful for and essential to: numerical weather prediction as initial data, especially in the tropical areas and in the southern hemisphere; and the research of climate variation in relatively short periods, the order of 2 to 3 years. The problems caused by cloud motion winds are discussed. Author

**N87-29992#** Japan Marine Science and Technology Center, Tokyo.
**STATISTICAL ANALYSES OF WIND FIELD OBTAINED FROM SHORT INTERVAL VISSR OBSERVATIONS**
Isao Takano and Kazuo Saito *In* Meteorological Satellite Center, Meteorological Satellite Center Technical Note No. 14, 1986 Dec. 1986 p 29-37 (For primary document see N87-29990 24-47)
Avail: NTIS HC A05/MF A01

Low level wind vectors in high spatial resolution were derived by an auto-tracking technique from short-time interval Visible Infrared Spin Scan Radiometer (VISSR) observations over the Japan Sea in November 1984. Statistical features of the wind field were examined. Auto correlation analysis showed strong anisotropy of both u and v components of the wind. Random errors of the derived wind data were estimated by means of structure functions and showed some dependency on two auto-tracking parameters, i.e., template sizes and scan-time intervals. Derived vector numbers decreased remarkably as scan-time intervals increased. Author

**N87-29993#** Meteorological Satellite Center, Tokyo (Japan).
**AN ESTIMATION OF PRECIPITATION INTENSITY FROM GMS DATA BY USING DIGITAL ECHO INTENSITY: A CASE STUDY OF COMPOSITE ESTIMATE MAKING BY MEANS OF MAN-MACHINE INTERACTIVE MODE**
Toshihiro Motoki, Singo Osano, and Nobuki Sato *In its* Meteorological Satellite Center Technical Note No. 14, 1986 Dec. 1986 p 39-52 (For primary document see N87-29990 24-47)
Avail: NTIS HC A05/MF A01

Through application of regression analysis to visible and infrared channel data of the GMS and the digital radar echo intensity data, a rainfall intensity estimation technique was developed. This technique, to be referred to as the automatic mode, is extended to the man-machine interactive mode. The man-machine interactive mode is designed to make a composite estimate and to compare the accuracy of two modes. Applying the man-machine interactive mode, a composite estimate for GMS data at 03GMT May 1, 1984, was made for comparison with the same data reported by

Motoki and Osano (1985). The accuracy of estimates from the two modes was measured by the correlation coefficient between the estimated values and the digital radar echo intensity data. The correlation coefficient derived from the automatic mode was 0.676, while that of the man-machine interactive mode was improved by about 10 percent to 0.745. Author

**N87-29994#** Meteorological Satellite Center, Tokyo (Japan).
**EXTRACTION OF INFRARED CLOUD-FREE RADIANCE FROM BOTH VISIBLE AND INFRARED SATELLITE IMAGE DATA**
Hiroshi Fukimura and Akihiro Uchiyama *In its* Meteorological Satellite Center Technical Note No. 14, 1986 Dec. 1986 p 53-61 (For primary document see N87-29990 24-47)
Avail: NTIS HC A05/MF A01

One of the methods to derive a cloud free infrared radiance is described using both the visible and infrared data. In the current operational procedure, the histogram analysis and the threshold method are used to extract the cloud free infrared radiance or brightness temperature (TBB) from the histogram data in the area 1 x 1 deg. This method cannot resolve a smaller structure than the dimension 1 x 1 deg area and the influence of the radiance from the cloudy area on the observed radiance cannot be removed. In order to overcome these difficulties, the utilization of the visible channel data is to be advantageous because of the smaller spatial resolution of the visible channel than that of the infrared channel. Using the visible data in the field of view of infrared channel, the cloud free area is more easily distinguished from cloudy and partially cloudy area. The relation between the cloud albedo in the visible region and the infrared emissivity of the cloud enables the derivation of the cloud free radiance from the partially cloudy area. The relationship between the visible cloud albedo and the infrared cloud emissivity is parameterized on the basis of the solution on a simple 2-stream radiative transfer equation. Author

**N87-29995#** Lamont-Doherty Geological Observatory, Palisades, N.Y.
**RECENT CLIMATE CHANGE IN NORTH AMERICA AND CO2: SEARCH IN STRATIFIED DAILY DATA Progress Report, 30 Apr. 1986 - 30 Apr. 1987**
G. J. Kukla May 1987 10 p
(Contract DE-FG02-85ER-60372)
(DE87-012411; DOE/ER-60372/2) Avail: NTIS HC A02/MF A01

The objectives were: (1) to identify the CO2 fingerprint in stratified daily weather records available since 1900; (2) to characterize recent climate fluctuations in North America in terms of the changing frequency and distribution of various daily weather types; and (3) to determine empirical relationships of humidity, cloud cover, wind, precipitation, snow, etc., to surface air temperature and to use this information for improvements of the input to climate models. The results indicate: (1) a relative warming of urban sites with respect to the countryside; (2) a significant decrease of the diurnal temperature range has taken place; (3) an increase of minimum temperatures under overcast skies; and (4) an increase in both minima and maxima under clear skies. DOE

**N87-29996*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**FIVE YEAR GLOBAL DATASET: NMC OPERATIONAL ANALYSES (1978 TO 1982)**
David Straus and Joseph Ardizzone Sep. 1987 50 p Prepared in cooperation with Sigma Data Services Corp., Rockville, Md.
(NASA-RP-1194; Rept-87B0273; NAS 1.61:1194) Avail: NTIS HC A03/MF A01 CSCL 04B

This document describes procedures used in assembling a five year dataset (1978 to 1982) using NMC Operational Analysis data. These procedures entailed replacing missing and unacceptable data in order to arrive at a complete dataset that is continuous in time. In addition, a subjective assessment on the integrity of all data (both preliminary and final) is presented. Documentation on tapes comprising the Five Year Global Dataset is also included. Author

**N87-29997#** Royal Netherlands Meteorological Inst., De Bilt. Ministerie van Verkeer en Waterstaat.
**[ACTIVITIES REPORT IN METEOROLOGY] Annual Report, 1985 [JAARVERSLAG 85]**
1985 97 p In DUTCH
(ISSN-0169-1902; ETN-87-90168) Copyright Avail: NTIS HC A05/MF A01

The 25 yr history of the Dutch coastal weather station Zierikzee is depicted. The service, scientific research efforts, international cooperation, personnel structure, infrastructure, and supporting activities are presented. ESA

**N87-29998#** METSAT, Inc., Fort Collins, Colo.
**ESTIMATE OF ELECTRO-OPTICAL METEOROLOGICAL PARAMETERS FROM SATELLITE-DETECTED RADIANCES Final Report, Aug. 1985 - Aug. 1986**
T. H. VonderHaar and M. Wetzel Mar. 1987 59 p
(Contract N66001-85-C-0202; Proj. W59-551)
(AD-A182957; NOSC-TD-1074) Avail: NTIS HC A04/MF A01 CSCL 04B

Described is research that includes the implementation of atmospheric transmission models, collection and analysis of digital image data from GOES, DMSP, and NOAA satellites, development of a monochromatic radiative transfer model for marine stratus clouds, and the design and testing of a spectral radiometer for marine boundary layer applications. Submarines of the research project and results are improved in the report. Section 2 describes the analysis of estimating clear-sky atmospheric transmittance from satellite data. Section 3 summarizes the research pertaining to remote sensing applications for boundary layer clouds. GRA

**N87-29999#** Bohan (Walter A.) Co., Park Ridge, Ill.
**NAVY TACTICAL APPLICATIONS GUIDE. VOLUME 6, PART 1: TROPICS WEATHER ANALYSIS AND FORECAST APPLICATIONS Final Report, 13 Sep. 1985 - 12 Sep. 1986**
Robert W. Fett and Walter A. Bohan Aug. 1986 234 p
(Contract N00228-85-C-3398)
(AD-A183046; NEPRF-TR-86-02-V6-Pt-2) Avail: NTIS HC A11/MF A01 CSCL 04B

The Navy Tactical Applications Guide (NTAG), Volume 6, is devoted to regional weather analysis and forecast applications of meteorological satellite imagery in the tropics. Part 1 deals with operationally significant phenomena and effects in the tropics, excluding tropical cyclones. Part 2, to be published at a later date, will focus on tropical cyclone genesis and evolution in areas around the globe. The volume is organized into four regional areas: Tropical Atlantic Ocean, Tropical Eastern Pacific Ocean (EASTPAC), Tropical Western Pacific Ocean (WESTPAC), and Tropical Indian Ocean. In each section, synoptic-scale phenomena are discussed first, followed by mesoscale phenomena. A number of new analysis techniques, never before published, appear in this volume. The analysis techniques will be useful to Navy meteorologists aboard ships operating in coastal regions or in mid-ocean transit. GRA

**N87-30000#** Naval Postgraduate School, Monterey, Calif.
**SINGLE-STATION FORECASTING WITH INTERACTIVE COMPUTER SYSTEMS Technical Report, Oct. 1985 - May 1987**
Carlyle H. Wash May 1987 43 p
(AD-A183077; NPS-63-87-004) Avail: NTIS HC A03/MF A01 CSCL 04B

The rapid advance of interactive computer systems provides many opportunities to assist the synoptic meteorologist in giving improved environmental support. These systems permit computer managed data sets, the presentation of integrated displays of surface, upper-air, satellite and/or radar data and the computation of derived parameters and simple models to assist forecast decisions. All major national meteorological services are developing prototype interactive systems. The Tactical Environmental Support System (TESS), developed for the U.S. Navy, is already in use in the fleet in preliminary form. A more sophisticated version, TESS (3), will be introduced by the end of the decade. These interactive

systems can dramatically enhance the effectiveness of the meteorological watch section on a major ship, airfield or regional forecast facility. Major components of these improvements include both software and hardware tools to facilitate the enhanced productivity of the forecaster. GRA

**N87-30001#** Naval Postgraduate School, Monterey, Calif.
**INVESTIGATION OF ANOMALOUS CLOUD FEATURES IN 3.7 MICROMETER SATELLITE IMAGERY M.S. Thesis**
John M. Rogers Mar. 1987 83 p
(AD-A183200) Avail: NTIS HC A05/MF A01 CSCL 04A

When band 3 (3.7 micrometers) daylight AVHRR imagery are examined, unique effects not present in the other four bands are observed. These effects include a higher radiance from cloud tops than from the sea-surface, unique ship exhaust tracks and the highlighting of areas of thin clouds, continental aerosol intrusion into marine air and ice clouds. These effects are due to the addition of various amounts of reflected solar radiance and thermal emitted radiance. In this thesis, three cases illustrating these effects are examined. The apparent temperature reversals result from clouds reflecting more solar radiation than the sea surface. Ship tracks and continental aerosol effects are due to altered size distributions caused by added ship exhaust pollutants or aerosols. The absorptivity of ice clouds is higher than water clouds, thus the sensed radiance from ice clouds is essentially only emitted, not reflected. Therefore, ice clouds appear colder than liquid water clouds in band 3. GRA

**N87-30002#** Naval Postgraduate School, Monterey, Calif.
**DIAGNOSTIC STUDY OF A GENESIS OF ATLANTIC LOWS EXPERIMENT (GALE) CYCLOGENESIS EVENT M.S. Thesis**
Daniel J. Soper Mar. 1987 139 p
(AD-A183333) Avail: NTIS HC A07/MF A01 CSCL 04B

The Navy Operational Regional Atmospheric Prediction System (NORAPS) analysis and forecasts, with 80 km resolution, are used to investigate an explosive cyclogenesis event that occurred in Intensive Observation Period (IOP) 2 during 26-28 January 1986. A synoptic investigation and quasi-Lagrangian diagnostic evalation of the primary cyclone mass, vorticity, heat and moisture budgets are discussed. Explosive developement occurs with the superposition of an upper-level jet streak over a shallow surface system associated with a well developed coastal front. The avection of shear vorticity aloft in combination with warm advection induces strong low-level convergence and spin-up of the low-level vortex. Significant surface sensible and latent heat fluxes and latent heating maxima are closely correlated with the period of rapid development from 00-12 GMT 227 January 1986. GRA

**N87-30003#** Air Force Environmental Technical Applications Center, Scott AFB, Ill.
**CUMULUS CLOUD DIMENSION STATISTICS FOR NEW ORLEANS, ESSEN AND HANNOVER**
Randell J. Barry Jun. 1987 71 p
(AD-A183376; USAFETAC/PR-87-001) Avail: NTIS HC A04/MF A01 CSCL 04B

Methods used in the study of cloud dimensions have included analyses of aircraft and satellite stereographic photos, use of radar echo data, and numerical simulation of growing clouds. This kind of research is important from a military perspective because of the effects clouds can have on remote sensing devices such as the Infrared Search and Tracking System. USAFETAC developed a new and simple method to quantify selected cumulus cloud dimensions. Using a 10-year sample from the USAFETAC surface and upper-air databases, statistics for minimum, maximum, mean cloud base height, cloud top height, and cloud cover amount were produced for three locations: Essen and Hannover, West Germany, and New Orleans, Louisiana. Statistics were compiled for three different cumulus cloud types in two categories: monthly, and hourly by season. The frequency and percent frequency occurrence of cumulus cloud types were also calculated. Most statistics were produced from surface observations, but cloud top statistics were obtained from a one-dimensional cumulus cloud model that uses both surface and upper-air data. Graphic illustrations of selected cloud dimensions appear as figures in Appendix B. GRA

**N87-30004#** SASC Technologies, Inc., Lexington, Mass.
**OBJECTIVE ANALYSIS AND PREDICTION TECHNIQUES Final Report, 1 Dec. 1985 - 30 Nov. 1986**
Alan M. Gerlach 30 Nov. 1986 268 p
(Contract F19628-82-C-0023)
(AD-A183450; SCITNTIFIC-12; AFGL-TR-87-0013) Avail: NTIS HC A12/MF A01 CSCL 04B

Part One reports on research performed in 1986 in numerical weather prediction, mesoscale forecasting, boundary layer meteorology, radar meteorology, satellite meteorology, and design climatology. Part Two provides five-year surveys of research activities in those technical areas. GRA

**N87-30005#** Hebrew Univ., Jerusalem (Israel).
**THE EFFECT OF METEOROLOGICAL CONDITIONS ON TRANSMISSION OF RADIATION AND IMAGING THROUGH NATURAL DUSTY ENVIRONMENTS Final Report, 1 Jun. 1985 - 31 May 1986**
Louis Berkofsky, A. Cohen, N. Kopeika, Z. Levin, and U. Oppenheim 31 Jul. 1986 58 p
(Grant AF-AFOSR-0285-85)
(AD-A183539; AFGL-TR-87-0119) Avail: NTIS HC A04/MF A01 CSCL 04B

The transmission of radiation is affected by dust and by turbulence. It would be desirable to be able to predict the degree of turbulence and the dust concentration. As a prelude to carrying out experiments in the Negev Desert to gather appropriate data leading to development of a prediction model, we have selected a site and prepared climatological data for that site. Contents--Dust Storms at Sede Boqer: Distribution of Dust Storm Observations According to Month of the Year, Frequency of Wind Directions During Dust Storm Observations According to the Month of the Year, Percentage Frequency of Wind Directions at Times of Dust Storms at Sede Boqer, Distribution of Dust Storms at Sede Boqer According to Wind Direction and Velocity; Meteorological data for Sede Boqer: Station Instrumentation, Temperature Data, Temperature and Humidity Variables at 14:00 Local Time, Rainfall, Dew and Evaporation. GRA

**N87-30006#** Massachusetts Inst. of Tech., Cambridge. Center for Meteorology and Physical Oceanography.
**CLIMATE SENSITIVITY AND LONG-PERIOD TEMPERATURE FLUCTUATIONS Final Report, 4 Mar. 1986 - 4 Mar. 1987**
Edward N. Lorenz Mar. 1987 24 p
(Contract F19628-86-K-0001)
(AD-A183540; AFGL-TR-87-0124) Avail: NTIS HC A02/MF A01 CSCL 04B

A special low-order moist general-circulation model is found to produce long-period fluctuations in the globally averaged atmospheric temperature, resembling the variations that have occurred in the real atmosphere. We propose that the fluctuations in the model, and possibly some of those in the atmosphere, occur because the sensitivity of the diabatic heating to temperature is highly variable. We construct a much simpler model, in which the diabatic heating is given by a simple function of temperature and local planetary temperature that approximates the diabatic heating in the original model, while the advective temperature changes are represented by random numbers. The new model produces similar long-period temperature fluctuations, thereby tending to support our hypothesis. Author (GRA)

**N87-30007#** Chase Consulting, Inc., San Diego, Calif.
**INITIAL PROCESSING OF SPACE SHUTTLE CLOUD PHOTOGRAPHS, PHASE 1 Final Report, Aug. 1986 - Feb. 1987**
Leonid B. Volfson, Charles Peet, and Catherine Gautier 28 Mar. 1987 70 p
(Contract F19628-86-C-0149)
(AD-A183543; AFGL-TR-87-0181) Avail: NTIS HC A04/MF A01 CSCL 04B

Techniques are described for computer analysis of series of photographs of specific cloud scenes taken from the space shuttle. A method for extracting high resolution navigational information from the space shuttle hand-held camera imagery has been developed. Also, methods are applied which differentiate cloudy from clear areas with both ocean and land backgrounds and over a wide range of viewing geometries. Three specific objectives are achieved: (1) Develop and implement high resolution digitization of the photographic transparencies so they can be automatically processed by the computer; (2) Develop and implement rectification techniques that will provide angle from nadir, and geographical and scale information that can be associated with each feature on the transparencies; (3) Apply a statistical cloud classification technique to assess the amount and the spatial variability of the cloud fields. This work is to be continued to produce a fully operational methodology permitting benefits of this research to be realized in a real-time assessment environment. Cloud properties studies can provide a potentially valuable new tool for improving weather prediction. GRA

# 48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

**N87-30008#** Dynalysis of Princeton, N.J.
**SOUTH ATLANTIC OCS (OUTER CONTINENTAL SHELF) CIRCULATION MODEL, PHASE 3 (REVISED)**
L. H. Kantha, H. J. Herring, and G. L. Mellor Dec. 1986 171 p
(Contract DI-14-12-0001-29203)
(PB87-200077; OCS/MMS-86/0120-Rev; DYNALYSIS-91-Rev)
Avail: NTIS HC A08/MF A01 CSCL 08C

The primary research activity in the present study is to demonstrate that the General Circulation Model embodies the physics required to produce the observed Gulf Stream variability. The results show that given adequate grid resolution and appropriate boundary conditions the model does produce qualitatively realistc shingles and intrusions along the western boundary of the Gulf Stream. Another important component of the study is to provide circulation fields for immediate application to satisfy Minerals Management Service oil spill modelling requirements. Climatological distributions of the various water mass characteristics, wind stresses and heat fluxes have been produced. The domain for which data has been analyzed encompasses the coastal waters of the east coast of the United States. GRA

**N87-30009#** Walcoff and Associates, Inc., Alexandria, Va.
**PROCEEDINGS OF ATLANTIC OUTER CONTINENTAL SHELF REGION INFORMATION TRANSFER MEETING (ITM) (2ND), JANUARY 28-29, 1987**
G. J. Gould May 1987 103 p Meeting held in Arlington, Va., 28-29 Jan. 1987
(Contract DI-14-12-0001-30337)
(PB87-200168; OCS/MMS-87/0033) Avail: NTIS HC A06/MF A01 CSCL 08C

The second Information Transfer Meeting (ITM) for the Atlantic Outer Continental Shelf (OCS) included 20 presentations followed by discussions. The purpose of the ITM is to communicate research results of the Environmental Studies Program and programs funded by other organizations which are relevant to OCS environmental management issues to an audience of state and Federal agencies, environmental organizations, industry and other decision-making groups. An overview was given of the Outer Continental Shelf Environmental Studies Program introducing a day of detailed presentations on active and recently completed North, Mid-, and South Atlantic, and Multi-Regional Studies. The second day was devoted to panel discussions on non-energy minerals on the Atlantic OCS and environmental concerns on the Georges Bank. Summaries of all presentations are included. GRA

**N87-30010#** IceCasting, Inc., Seattle, Wash.
**INTERPOLATION, ANALYSIS AND ARCHIVAL OF DATA ON SEA ICE TRAJECTORIES AND OCEAN CURRENTS OBTAINED FROM SATELLITE-LINKED INSTRUMENTS Final Report**
R. S. Pritchard and D. J. Hanzlick Apr. 1987 126 p Sponsored by NOAA, Anchorage, Alaska and Minerals Management Service, Juneau, Alaska
(PB87-201430; ICI-RPT-87010) Avail: NTIS HC A07/MF A01 CSCL 08C

Described are the movement of 17 ARGOS buoys deployed on ice floes in the northern Bering and Chukchi Seas. The analysis is based on the geographical position, meteorology and ocean current data obtained from satellite-linked instruments. Ice motion histories showed that diurnal tide oscillations dominated the short-term velocity behavior in Norton Sound. In contrast, there was no significant tidal velocity component in the Chukchi Sea. It was shown that 58-60% of the daily ice velocity variance in Norton Sound was explained by the currents, whereas in Chukchi Sea currents accounted for 44-93% of the ice velocity variance. These differences might be attributed to internal ice stress divergence, non-geostrophic currents, or other unknown factors. GRA

**N87-30011#** Walcoff and Associates, Inc., Alexandria, Va.
**PROCEEDINGS OF ATLANTIC OUTER CONTINENTAL SHELF REGION INFORMATION TRANSFER MEETING (ITM) (1ST), SEPTEMBER 4-6, 1985**
G. J. Gould 1986 127 p Meeting held in Crystal City, Va., 4-6 Sep. 1985
(Contract DI-14-12-0001-30337)
(PB87-194361; OCS/MMS-85/0106) Avail: NTIS HC A07/MF A01 CSCL 08C

The first Information Transfer Meeting (ITM) for the Atlantic OCS included 35 presentations over a two-and-a-half day period. The goal of the ITM is to present technical information in a context useful to OCS decision-makers. The results of the Region's Environmental Studies Program were presented as well as reports on Federal and state coastal management activities, petroleum resource estimation, and industry's oil-spill technology. Summaries of all presentations are included in the document. GRA

**N87-30012#** Science Applications International Corp., Newport, R.I.
**STUDY OF PHYSICAL PROCESSES ON THE US MID-ATLANTIC CONTINENTAL SLOPE AND RISE. VOLUME 1: EXECUTIVE SUMMARY Final Report, Sep. 1983 - May 1987**
O. Brown, R. Evans, R. Watts, C. Casagrande, and P. Hamilton May 1987 53 p
(Contract DI-14-12-0001-30066)
(PB87-200515; SAIC-86/7539/129-Vol-1;
OCS/MMS-87/0024-Vol-1) Avail: NTIS HC A04/MF A01; also available in set of 3 reports HC E99 as PB87-200507 CSCL 08C

Three years of physical oceanographic research in the Mid-Atlantic Slope and Rise (MASAR) Program are described. The data was collected to provide sufficient information to allow assessment of the potential impacts of petroleum exploration and production activities on the outer continental shelf (OCS) of the Mid-Atlantic region. Major tasks undertaken were: determination of the general seasonal circulation features; quantification and description of the processes which produce variability; and determination of the degree to which the slope/rise circulation features influence the physical oceanography of the adjacent Mid-Atlantic continental shelf. The data were collected using instrumented moorings, satellite infrared imagery, and hydrographic sampling. The collected data is being used in models to estimate potential coastal pollution from offshore activities. B.G.

**N87-30013#** Science Applications International Corp., Newport, R.I.
**STUDY OF PHYSICAL PROCESSES ON THE US MID-ATLANTIC CONTINENTAL SLOPE AND RISE. VOLUME 2: TECHNICAL PRESENTATION Final Report, Sep. 1983 - May 1987**
O. Brown, R. Evans, R. Watts, C. Casagrande, and P. Hamilton

May 1987 326 p
(Contract DI-14-12-0001-30066)
(PB87-200523; SAIC-86/7539/129-Vol-2;
OCS/MMS-87/0024-Vol-2) Avail: NTIS HC A15/MF A01; also available in set of 3 reports HC E99 as PB87-200507 CSCL 08C

Described are three years of physical oceanographic research by Science Applications International Corporation (SAIC) and its subcontractors in the Mid-Atlantic Slope and Rise (MASAR) program. MASAR began in October 1983 and was designed to provide the Department of Interior's Minerals Management Service (MMS) with sufficient information to allow assessment of the potential impacts of petroleum exploration and production activities on the Outer Continental Shelf (OCS) of the Mid-Atlantic region. Several major tasks were undertaken: determining the general seasonal circulation features; quantifying and describing processes which produce variability; and determining the degree to which the slope/rise circulation features influence the physical oceanography of the adjacent Mid-Atlantic continental shelf.

GRA

**N87-30014#** Science Applications International Corp., Newport, R.I.

**STUDY OF PHYSICAL PROCESSES ON THE US MID-ATLANTIC CONTINENTAL SLOPE AND RISE. VOLUME 3: APPENDIX Final Report, Sep. 1983 - May 1987**

O. Brown, R. Evans, R. Watts, C. Casagrande, and P. Hamilton May 1987 146 p
(Contract DI-14-12-0001-30066)
(PB87-200531; SAIC-86/7539/129-Vol-3;
OCS/MMS-87/0024-Vol-3) Avail: NTIS HC A07/MF A01; also available in set of 3 reports HC E99 as PB87-200507 CSCL 08C

Described are three years of physical oceanographic research by Science Applications International Corporation (SAIC) and its subcontractors in the Mid-Atlantic Slope and Rise (MASAR) program. MASAR began in October 1983 and was deigned to provide the Department of Interior's Minerals Management Service (MMS) with sufficient information to allow assessment of the potential impacts of petroleum exploration and production activities on the outer continental shelf (OCS) of the Mid-Atlantic region. Several major tasks were undertaken: determining the general seasonal circulation features; quantifying and describing processes which produce variability; and determining the degree to which the slope/rise circulation features influence the physical oceanography of the adjacent Mid-Atlantic continental shelf.

GRA

**N87-30015#** Florida State Univ. System, St. Petersburg. Inst. of Oceanography.

**PHYSICAL OCEANOGRAPHIC STUDY OF FLORIDA'S ATLANTIC COAST REGION: FLORIDA ATLANTIC COAST TRANSPORT STUDY (FACTS). VOLUME 1: EXECUTIVE SUMMARY Final Report, 9 Jan. 1984 - 18 Feb. 1986**

M. Rinkel, S. Vargo, T. Lee, F. Schott, and R. Zantopp 15 Sep. 1986 54 p Sponsored by Minerals Management Service, Vienna, Va.
(Contract DI-14-12-0001-30082)
(PB87-200994; OCS/MMS-86/0079-Vol-1) Avail: NTIS HC A04/MF A01; also available in set of 3 reports HC E99 as PB87-200986 CSCL 08C

Information is provided on the eddy structures which were observed to break off from the Florida Current and Gulf Stream along Florida's Atlantic coast from 27 deg N to 30 deg N to aid in assessment of risks from oil and gas activities in the South Atlantic Planning Area. Satellite sea surface temperature (SST) imagery was used as a supplementary tool in the study to help interpret the data from the field instrumentation. Field sampling was conducted from 12 March 1984 through 19 June 1985. This volume 1 of a 3 volume set contains the executive summary.

GRA

**N87-30016#** Florida State Univ. System, St. Petersburg. Inst. of Oceanography.

**PHYSICAL OCEANOGRAPHIC STUDY OF FLORIDA'S ATLANTIC COAST REGION: FLORIDA ATLANTIC COAST TRANSPORT STUDY (FACTS), VOLUME 2 Final Report, 9 Jan. 1984 - 18 Feb. 1986**

M. Rinkel, S. Vargo, T. Lee, F. Schott, and R. Zantopp 15 Sep. 1986 429 p Sponsored by Minerals Management Service, Vienna, Va.
(Contract DI-14-12-0001-30082)
(PB87-201000; OCS/MMS-86/0079-Vol-2) Avail: NTIS HC A19/MF A01; also available in set of 3 reports HC E99 as PB87-200986 CSCL 08C

Information is provided on the eddy structures which were observed to break off from the Florida Current and Gulf Stream along Florida's Atlantic coast from 27 deg N to 30 deg N to aid in assessment of risks from oil and gas activities in the South Atlantic Planning Area. The study involved the combined use of moored current meter arrays, PEGASUS current profiler, satellite tracked surface drifters, and inverted echo sounder/bottom pressure gauges (IES/PGs) to directly measure currents and particle trajectories with the Florida Current and Gulf Stream and the adjacent shelf.

GRA

**N87-30017#** Florida State Univ. System, St. Petersburg. Inst. of Oceanography.

**PHYSICAL OCEANOGRAPHIC STUDY OF FLORIDA'S ATLANTIC COAST REGION: FLORIDA ATLANTIC COAST TRANSPORT STUDY (FACTS). VOLUME 3: APPENDICES Final Report, 9 Jan. 1984 - 18 Feb. 1986**

M. Rinkel, S. Vargo, T. Lee, F. Schott, and R. Zantopp 15 Sep. 1986 218 p Sponsored by Minerals Management Service, Vienna, Va.
(Contract DI-14-12-0001-30082)
(PB87-201018; OCS/MMS-86/0079-Vol-3) Avail: NTIS HC A10/MF A01; also available in set of 3 reports HC E99 as PB87-200986 CSCL 08C

The goal of the study was to provide information on the eddy structures which had been observed to break off from the Florida Current and Gulf Stream along Florida's Atlantic Coast from 27 to 30 degrees N to aid in the assessment of risks from oil and gas activities in the South Atlantic Planning Area. The study involved the combined use of moored current meter arrays. PEGASUS current profiler, satellite tracked surface drifters, and inverted echo sounder/bottom pressure gauges (IES/PGs) to directly measure currents and particle trajectories with the Florida Current and Gulf Stream and the adjacent shelf. Satellite sea surface temperature (SST) imagery was used as a supplementary tool in the study to help interpret the data from the field instrumentation. Field sampling was conducted from March 12, 1984 through June 12, 1985.

GRA

**N87-30018*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**NASA SEA ICE AND SNOW VALIDATION PLAN FOR THE DEFENSE METEOROLOGICAL SATELLITE PROGRAM SPECIAL SENSOR MICROWAVE/IMAGER**

Donald J. Cavalieri, ed. and Calvin T. Swift, ed. Sep. 1987 81 p
(NASA-TM-100683; Rept-87B0492; NAS 1.15:100683) Avail: NTIS HC A05/MF A01 CSCL 08C

This document addresses the task of developing and executing a plan for validating the algorithm used for initial processing of sea ice data from the Special Sensor Microwave/Imager (SSMI). The document outlines a plan for monitoring the performance of the SSMI, for validating the derived sea ice parameters, and for providing quality data products before distribution to the research community. Because of recent advances in the application of passive microwave remote sensing to snow cover on land, the validation of snow algorithms is also addressed. Author

**N87-30019#** Coast Guard Research and Development Center, Groton, Conn.
**ARCTIC DRIFTING BUOY DATA 1979 - 1985 Final Report**
Joseph W. St.Martin Apr. 1987 126 p
(AD-A182967; CGR/DC-07/87; USCG-D-10-87) Avail: NTIS HC A07/MF A01 CSCL 13J

As part of an investigation of potential Arctic oil spills, the U.S. Coast Guard Research and Development and Canadian Marine Drilling, Ltd. (CANMAR) released satellite-tracked drifting buoys at two sites in the southern Beaufort Sea during six years (1979 to 1983, 1985). The sites were near Canadian offshore drilling locations off the Tuktoyaktuk Peninsula, Northwest Territories and near Prudhoe Bay, Alaska. An analysis of the trajectories of these buoys indicated that the majority of buoy drift was in an alongshore (east/west) direction. When buoys did move in a north/south direction, their speeds were generally lower and the length of excursions shorter. A comparison of the drift of these buoys to the calculated geostrophic wind (east/west component only) revealed that, over a long term, the buoys drifted, on average, with the mean wind. Buoys had average drift speeds which varied from 1% to 5.5% of the mean wind. When cumulative drift was compared to the cumulative wind, high correlations were noted for those buoys with spar type hulls. This indicates that the cumulative large-scale geostrophic wind plays an important role in the cumulative movement of the upper 1-2 meters of the water column. A comparison of the trajectories of buoys which were released in close spacial and time proximity was conducted. In general, their drifts were variable enough to indicate that the total forcing function on separate buoys was different. Author (GRA)

**N87-30020#** SACLANT ASW Research Center, La Spezia (Italy).
**WAVE-THEORY MODELLING OF CONVERGENCE ZONE PROPAGATION IN THE OCEAN**
Giancarlo Dreini and Finn B. Jensen Jun. 1987 28 p
(AD-A183607; SACLANTCEN-SM-194) Avail: NTIS HC A03/MF A01 CSCL 20A

Improved numerical techniques together with advances in computer technology have made it feasible to study sound propagation in the deep ocean with wave-theory models and hence avoid the artifacts and approximations associated with standard ray-theory analysis techniques. We apply a computationally efficient normal-mode code to the problem of convergence zone propagation, which is the repetitive focusing of sound (every 40-60 km) in the upper part of the ocean for an acoustic source near the sea surface. We investigate the structure of the first 3 convergence zones as a function of geographical area (Mediterranean Sea and Atlantic Ocean), season (summer and winter), frequency (25-200 Hz), and source/receiver depth (15-300 m). It is shown that convergence-zone propagation only occurs under summer conditions, and that the focusing of sound is much stronger in the Atlantic than in the Mediterranean. Moreover the convergence zone length is around 60 km in the Atlantic and just 35-40 km in the Mediterranean. GRA

**N87-30021*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**SATELLITE-DERIVED ICE DATA SETS NO. 2: ARCTIC MONTHLY AVERAGE MICROWAVE BRIGHTNESS TEMPERATURES AND SEA ICE CONCENTRATIONS, 1973-1976**
C. L. Parkinson, J. C. Comiso, and H. J. Zwally May 1987 43 p
(NASA-TM-87825; NAS 1.15:87825) Avail: NTIS HC A03/MF A01 CSCL 08L

A summary data set for four years (mid 70's) of Arctic sea ice conditions is available on magnetic tape. The data include monthly and yearly averaged Nimbus 5 electrically scanning microwave radiometer (ESMR) brightness temperatures, an ice concentration parameter derived from the brightness temperatures, monthly climatological surface air temperatures, and monthly climatological sea level pressures. All data matrices are applied to 293 by 293 grids that cover a polar stereographic map enclosing the 50 deg N latitude circle. The grid size varies from about 32 X 32 km at the poles to about 28 X 28 km at 50 deg N. The ice concentration parameter is calculated assuming that the field of view contains only open water and first-year ice with an ice emissivity of 0.92. To account for the presence of multiyear ice, a nomogram is provided relating the ice concentration parameter, the total ice concentration, and the fraction of the ice cover which is multiyear ice. Author

**N87-29573#** Joint Publications Research Service, Arlington, Va.
**MAJOR MORPHOLOGIC FEATURES OF THE ATLANTIC OCEAN SURFACE Abstract Only**
R. Kh. Greku *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 99 Transl. into ENGLISH from Issledovaniye Zemli iz Kosmosa (Moscow, USSR), no. 1, Jan. - Feb. 1987 p 20-25 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

# 51 LIFE SCIENCES (GENERAL)

**N87-30022#** Utah Univ., Salt Lake City. Dept. of Electrical Engineering.
**BIOLOGICAL EFFECTS OF MILLIMETER-WAVE IRRADIATION Final Report, 15 Apr. 1984 - 31 Mar. 1986**
Om P. Gandhi, Douglas W. Hill, Luciano Furia, Magdy F. Iskander, and Deepak Ghodgaonkar Apr. 1987 93 p
(Contract F33615-84-K-0610)
(AD-A182890; UTEC-86-095; USAFSAM-TR-86-44) Avail: NTIS HC A05/MF A01 CSCL 06G

Experiments were conducted to verify the reported high degree of sensitivity of growth rates of yeast cultures to millimeter-wave irradiation in the band 41.650 to 41.798 GHz. A new irradiation chamber was designed and built to allow simultaneous irradiation and sham irradiation of recirculating suspension of saccharomyces cerevisiae maintained with a temperature difference of less than 0.01 C. No difference larger than plus or minus 4% was ever detected in the growth rates at any of the highly stabilized (within plus or minus 50 Hz) irradiation frequencies for which the effects had been reported by earlier workers. Experiments were also performed to determine the Raman Spectra of cultures of bacillus megaterium to investigate if these are dependent on the stage of their life cycle. The results were negative. A further study to investigate the ability of millimeter waves to induce conformational changes in lipid bilayers of dipalmitoyl phosphatidycholine (DPPC) liposomes below and above the transition temperature of 41 C also gave negative results. For these experiments the conformational characteristics of the liposomes were evaluated using Raman spectra with and without mm-wave irradiation at 41.650 GHz. GRA

**N87-30023#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
**AN ELECTRICAL CIRCUIT MODEL OF THE INTERFACE BETWEEN AN ELECTRODE AND THE ELECTROLYTIC MEDIUM OF THE CORTEX M.S. Thesis**
Jeffrey M. Sedlak 31 Jul. 1987 383 p
(AD-A183204; AFIT/GE/EE/86D-48) Avail: NTIS HC A17/MF A01 CSCL 09A

Former research of the visual processes that occur at the cortex of mammals concentrated on the task of the design and implantation of a multielectrode array, the AFIT brain chip. Despite the importance of refining these activities, questions were generated from data collected during the first implant that need to be resolved before the next implant into a higher-level primate is attempted. The specific nature of the interface between the electrodes and the electrolytic medium at the cortex is critical to understanding and interpreting data collected during an implantation. The primary thrust of this research is to propose a qualitative model of the electrode/electrolyte interface and then

to calculate the quantitative parameters of that model by immersing brain chips into a simulated electrolyte and recording empirical data. The secondary focus of this research is to investigate the limiting effect of the electrode/electrolyte interface upon the maximal scan rate or the multielectrode array. GRA

**N87-30024#** Washington Univ., Seattle. Bioelectromagnetics Research Lab.
**AFFERENT MECHANISMS OF MICROWAVE-INDUCED BIOLOGICAL EFFECTS Final Report, Jun. 1980 - Aug. 1987**
H. Lai, A. Horita, C. K. Chou, and A. W. Guy 12 Aug. 1987 14 p
p
(Contract N00014-80-C-0354; DA Proj. RR0-4108)
(AD-A183562) Avail: NTIS HC A02/MF A01 CSCL 06G

Effects of low-level microwave irradiation on neurological function were investigated in the rat. Results can be summarized in the following statements: (1) acute exposure effects the response of an animal to psychoactive drugs and changes cholinergic activity in the brain; (2) effects of microwaves are classically conditionable to environmental cues after repeated exposure. Tolerance can also develop after repeated exposure; and (3) endogenous opioids play a mediating role in certain neurological effects of microwaves. These data further our understanding on the neurological effects of microwave exposure and may have important implications in certain occupational situations in which repeated exposure to low-level microwaves is unavoidable. GRA

# 52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**N87-30025*#** Brown Univ., Providence, R. I. Dept. of Lab. Medicine.
**GROWTH FACTOR INVOLVEMENT IN TENSION-INDUCED SKELETAL MUSCLE GROWTH Semiannual Status Report, 1 Apr. - 31 Sep. 1987**
H. H. Vandenburgh 1987 8 p
(Grant NAG2-414)
(NASA-CR-181349; NAS 1.26:181349) Avail: NTIS HC A02/MF A01 CSCL 06P

Muscle tissue culture techniques were developed to grow skeletal myofibers which differentiate into more adult-like myofibers. Mechanical simulation studies of these muscle cells in a newly developed mechanical cell simulator can now be performed to study growth processes in skeletal muscle. Conditions in the mechanical cell simulator were defined where mechanical activity can either prevent muscle wasting or stimulate muscle growth. The role of endogenous and exogenous growth factors in tension-induced muscle growth is being investigated under the defined conditions of tissue culture. M.G.

**N87-30026#** School of Aerospace Medicine, Brooks AFB, Tex. Radiation Physics Branch.
**PROCEEDINGS OF A WORKSHOP ON RADIOFREQUENCY RADIATION BIOEFFECTS Final Report**
John C. Mitchell, ed. Apr. 1985 242 p Workshop held in Wachtberg-Werthhoven, West Germany, 11-13 Sep. 1984; sponsored by NATO
(AF Proj. 7757)
(AD-A157090; USAFSAM-TP-85-14) Avail: NTIS HC A11/MF A01 CSCL 06R

The workshop addressed new developments in the field of Radio Frequency Radiation (RFR). Safety standards, assessment of RFR levels in the military environment, RFR instrumentation and dosimetry, biological effects of long-term low-level RFR exposures and pulsed versus continuous wave effects are among the topics discussed. For individual titles, see N87-30027 through N87-30039.

**N87-30027#** Utah Univ., Salt Lake City. Dept. of Electrical Engineering.
**PHYSICAL INTERACTIONS OF RADIOFREQUENCY RADIATION FIELDS AND BIOLOGICAL SYSTEMS**
Carl H. Durney *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 5-36 Previously announced as N85-27129 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

A biological system irradiated by radiofrequency radiation (RFR) responds to the internal RFR fields produced by that irradiation. The measurement and calculation of the internal fields is called dosimetry. The internal fields are often described in terms of the specific absorption rate (SAR) in watts/kilogram. A combination of techniques, each valid for a particular model and in a particular frequency range, are used to calculate average whole body SAR's for models of human beings and other animals over a wide frequency range for plane wave irradiation. Calculating SAR's for near field irradiation is much more difficult than for plane wave irradiation; thus, fewer near field SAR data are available. To calculate spatial distribution of SAR's is still more difficult (especially at higher frequencies); this problem in dosimetry is yet to be solved satisfactorily, although significant progress has recently been made in this area. Author

**N87-30028#** Yale Univ., New Haven, Conn.
**THERMAL PHYSIOLOGY OF RFR INTERACTIONS IN ANIMALS AND HUMANS**
Eleanor R. Adair *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 37-54 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

The description of thermoregulation in any endotherm involves detailed knowledge of thermoregulatory behavior, both instinctive and learned, as well as knowledge of autonomic processes of heat production and heat loss. It is shown that the particular autonomic response that may be ongoing at any given time is dictated by the prevailing environmental temperature. In other words, endotherms shiver in the cold and pant or sweat in the heat, but not the reverse, and they will avoid doing either if an efficient behavioral maneuver is available to them. Radiofrequency radiation (RFR) may be regarded as part of the thermal environment to which man and other endotherms may be exposed. The maintenance of heat balance in a body exposed to radiofrequency radiation is discussed. Author

**N87-30029#** School of Aerospace Medicine, Brooks AFB, Tex.
**CRITICAL REVIEW OF SELECTED TOPICS ON BIOLOGICAL EFFECTS OF RADIOFREQUENCY RADIATION**
Jerome H. Krupp, Louis N. Heynick, and Peter Polson (SRI International Corp., Menlo Park, Calif.) *In its* Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 55-84 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

Several selected reports regarding radio frequency radiation (RFR) bioeffects that were considered important with regard to possible hazards to human beings were critically reviewed. Researchers concluded that no reliable evidence indicates that chronic exposure to RFR at incident average power densities below 1 mW/square cm or at SAR's below 0.4 W/kg are hazardous to human health. Important uncertainties are reviewed. Author

**N87-30030#** School of Aerospace Medicine, Brooks AFB, Tex.
**RADIOFREQUENCY RADIATION SAFETY STANDARDS**
John C. Mitchell *In its* Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 85-102 Previously announced as N85-27137 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

Using a safety factor of 10, the American Standards Institute developed radio frequency radiation (RFR) protection guides that will limit all human whole body exposures to incident energy that results in a specific absorption rate (SAR) no greater than 0.4

W/kg. This allows incident average power densities from 1 to 100 mW/square cm depending upon the frequency of the radiation. New safety guidelines are compared with many other RFR standards used throughout the world. Author

**N87-30031#** Office of Naval Research, Arlington, Va.
**RFR RESEARCH PROJECTIONS FOR THE FUTURE**
Michael T. Marron *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 103-119 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

A review is given of where we are going in the field of bioelectromagnetics. It is concluded that research into the mechanisms by which electromagnetic fields interact with biological tissue will assume increasing importance in the next few years. The major new impetus for mechanism research will be derived from beneficial applications of electromagnetic fields to biological tissue. Use of electric and magnetic fields to promote healing is already widespread and will continue to increase. Author

**N87-30032#** School of Aerospace Medicine, Brooks AFB, Tex.
**THE CUMULATIVE EFFECTS OF LONG-TERM EXPOSURE TO LOW LEVELS OF RADIOFREQUENCY RADIATION (RFR)**
Jerome H. Krupp *In its* Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 121-133 Previously announced as N85-27132 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

Over a four-year period of planning, pilot study, and definitive experiment, a lifetime exposure is given to a population of test animals (100) whose state of health, growth, and cause of death are closely monitored. An equal number of sham expected animals served as a comparison population. After 25 months of exposure, at the point where there is 90 percent mortality in both groups, the remaining subjects are sacrificed and assayed. The overall conclusion is that no cumulative ill effects could be attributed to the life-long exposure at absorption rates of 0.4 W/kg or less. Author

**N87-30033#** School of Aerospace Medicine, Brooks AFB, Tex.
**HUMAN EXPOSURES TO RADIOFREQUENCY RADIATION (RFR). A REVIEW OF RFR ACCIDENTS**
John C. Mitchell *In its* Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 135-141 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

A review and analysis of Air Force radio frequency radiation (RFR) accident files were performed. The following conclusions are evident: (1) of the 296 suspected overexposures, only 58 (approx. 20 percent) were confirmed, the other 80 percent being within the permissible exposure limit; (2) about half of the overexposures were detected because the individual(s) felt a warming sensation; (3) essentially all of the exposures were partial body exposures; (4) actual exposure times were most often less than 6 minutes; and (5) most of these exposures occurred at frequencies between 1 and 10 GHz. Medical review of the physical examinations following RFR overexposure revealed few consistent clinical patterns. Erythema and/or edema were rare findings at the time of the examination. Lenticular findings such as vacuoles and opacities were noted in some overexposed individuals receiving radiation to the head. None of these findings, however, were deemed clinically significant since there was no concomitant visual impairment. Author

**N87-30034#** Defence Research Establishment, Ottawa. (Ontario).
**APPLICATION OF HUMAN WHOLE-BODY RF ABSORPTION MEASUREMENTS TO RFR SAFETY STANDARDS**
Douglas A. Hill *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 143-161 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

Human whole-body radiofrequency (RF) absorption rates were measured as a function of body orientation, wave impedance, separation from ground, and frequency (from 3 to 40 MHz). Results applicable to RF radiation protection are summarized. The worst-case radiation exposure situation is taken to be the far-field whole-body exposure of a man wearing footgear and standing on the ground plane. Assuming that 0.4 W/kg is a safe whole-body specific absorption rate (SAR), the permitted exposure levels (PEL's) set by the 1982 ANSI standard are well supported by researchers' results. On the other hand, PEL's set by NATO STANAG 2345 are unsafe at most frequencies from 5 to 40 MHz. RF currents through the feet of grounded subjects were also measured. For the maximum exposures permitted by the ANSI standard, the RF currents cause a localized SAR in the ankle region of 16 W/kg. Author

**N87-30035#** Laboratory for Electronic Development of the Armed Forces, Oegstgeest (Netherlands).
**EXPOSURE TO RADIOFREQUENCY FIELDS IN THE NETHERLANDS: MEASUREMENTS AND EVALUATION**
Augustinus B. Woltering *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 163-177 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

The activities carried out on behalf of the inventory of the power flux density (PFD) in the vicinity of civil radio frequency (RF) sources in the frequency band of 0.5 MHz to 18 GHz are discussed. A computer program that gives a general (theoretical) impression of the RF environment was developed. Information about civil transmitters was collected and relevant technical parameters to be used as input data for this computer program were deduced. Measurements in the vicinity of RF emitting equipment such as seal machines that are too complex to model theoretically were carried out. Author

**N87-30036#** London Univ. (England). Dept. of Physics.
**DIELECTRIC BEHAVIOUR OF WATER IN BIOLOGICAL MATERIAL WITH PARTICULAR REFERENCE TO BRAIN TISSUE**
Edward H. Grant *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 179-186 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

The absorption of microwave energy by biological material at frequencies in excess of 1 GHz is due mainly to the water content. Knowledge of the dielectric properties of water in biological material is therefore a necessary prerequisite for the calculation of energy deposition. However, the water of hydration immediately adjacent to biological macromolecules is subject to chemical forces different from those in bulk water and must in consequence exhibit different dielectric properties. The nature and proportion of this water vary considerably from one tissue to another and therefore need to be evaluated for each specific case. For adult rabbit brain material, dielectric measurements show that the water of hydration constitutes about 20 percent of the total while the remainer has dielectric properties similar to those of pure water. With brain tissue from recently born rabbits, the proportion of water of hydration is indistinguishable from zero. Author

**N87-30037#** Bundesgesundheitsamt, Neuherberg (West Germany). Inst. for Radiation Hygiene.
**EVALUATION OF HUMAN EXPOSURE TO LOW FREQUENCY FIELDS**
Jurgen H. Bernhardt *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 187-202 Previously announced as N85-27135 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

Threshold values of field strength or current density, inducing biological effects are compiled from experimental and theoretical studies. On the basis of these data it is possible to establish safe, dangerous and hazardous current density curves as a function of frequency. The criterion for the definition of injury is the elicitation

of ventricular fibrillation which must be avoided. To define exposure limits, the field strength or current density causing injury should be reduced by a factor exceeding 100. The arguments supporting this wide safety margin are discussed. The electric and magnetic field strength in the human environment is correlated with the corresponding electric current density induced in the human body. This enables safe, dangerous and hazardous levels of current density in the human body to be correlated with the external electric or magnetic field strength. Author

**N87-30038#** Forschungsinstitut fuer Hochfrequenzphysik, Werthhoven (West Germany).
**RADIOFREQUENCY RADIATION SAFETY GUIDELINES IN THE FEDERAL REPUBLIC OF GERMANY**
Klaus W. Hofmann *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 203-216 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

The German safety rules in the fields of electronics and electricity are summarized. Part 1 of the standard includes instructions on how to take measurements and how to do calculations so as to get comparable results. Part 2 is concerned mainly with direct effects of electric shock. Part 3, which exists only in draft form, includes guidelines for the protection against explosive gas-air mixtures. Part 4, which is still under consideration, deals with electroexplosive devices. Author

**N87-30039#** Defence Research Establishment, Ottawa. (Ontario).
**RADIOFREQUENCY RADIATION SAFETY OF TWO MANPACK TRANSCEIVERS (AN/PRC-515 AND AN/PRC-77)**
Douglas A. Hill *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects Apr. 1985 p 217-223 (For primary document see N87-30026 24-52)
Avail: NTIS HC A11/MF A01 CSCL 06R

The radiofrequency radiation (RFR) safety of two Canadian Forces manpack transceivers (AN/PRC-515 and AN/PRC-77) was studied by a university contractor. The relationship of his study to current thinking in the field of RFR safety is explained. The main findings are summarized and applied to operations. It is concluded that both transceivers are safe under all practical operating conditions. Author

**N87-30040#** Ottawa Univ. (Ontario). Dept. of Electrical Engineering.
**SPECIFIC ABSORPTION RATE DISTRIBUTIONS IN A HETEROGENEOUS MODEL OF THE HUMAN BODY AT RADIOFREQUENCIES**
S. S. Stuchly Jun. 1987 102 p
(Grant EPA-R-812156)
(PB87-201356; EPA/600/1-87/003) Avail: NTIS HC A06/MF A01 CSCL 06R

The electric field distribution of the rate of energy absorption referred to as the specific absorption rate (SAR) in a biological body is a complex function of several exposure parameters such as frequency, intensity of the incident field, polarization, source to object configuration (near field vs far field), and the body characteristics such as size, shape, and dielectric properties. An experimental approach was employed to determine SAR patterns in a full scale heterogeneous model of man exposed to radiofrequency fields at 160, 350, and 914 MHz in the far and near fields for two polarizations. The model had an anatomically correct shape and contained a skull, spinal cord, rib cage, and all major bones (except those in the feet and hands), brains, lungs, and muscle tissue. The square of the electric field inside the model was measured by a small diameter electric field probe. Data acquisition, exposure conditions, and data processing were under computer control. Specific circuitry including an optical link was used to interface the electric field probe with the computer. Extensive data were obtained, analyzed, and compared with the data for a homogeneous model. GRA

**N87-30041*** National Aeronautics and Space Administration, Washington, D.C.
**AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 302)**
Oct. 1987 55 p
(NASA-SP-7011(302); NAS 1.21:7011(302)) Avail: HC A04 CSCL 06E

This bibliography lists 131 reports, articles, and other documents introduced into the NASA scientific and technical information system in September, 1987. Author

**N87-30042#** Joint Publications Research Service, Arlington, Va.
**USSR REPORT: LIFE SCIENCES. BIOMEDICAL AND BEHAVIORAL SCIENCES**
29 Apr. 1987 93 p Transl. into ENGLISH from various Russian articles
(JPRS-UBB-87-009) Avail: NTIS HC A05/MF A01

Topics addressed include: aerospace medicine, agrotechnology; biochemistry; biophysics; immunology; pharmacology and toxicology; physiology; public health; radiation biology; nonionizing electromagnetic radiation; military medicine; laser bioeffects; epidemiology; and genetics. For individual titles, see N87-30043 through N87-30045.

**N87-30043#** Joint Publications Research Service, Arlington, Va.
**CIRCULATORY CHANGES IN CAROTID ARTERY BASIN IN RESPONSE TO ANTIORTHOSTASIS AND ANTIORTHOSTATIC BED REST Abstract Only**
B. M. Fedorov, Ye. N. Streltsova, and T. V. Sebekina *In its* USSR Report: Life Sciences. Biomedical and Behavioral Sciences 29 Apr. 1987 p 1 Transl. into ENGLISH from Fiziologiya Cheloveka (Moscow, USSR), v. 11, no. 5, Sep. - Oct. 1985 p 755-762 Original language document was announced in IAA as A86-15513 (For primary document see N87-30042 24-52)
Avail: NTIS HC A05/MF A01

The effect of antiorthostasis (AO) on circulation in the carotid pool was studied in healthy men placed in -8 deg head-down tilt, and in anesthesized dogs subjected to -45 or -90 deg AO. The 5-day-long antiorthostatic hypokinesia in men led to a decreased blood flow in the carotid and orbital arteries, an increase in the peripheral resistance index, a decreased reactivity to the compression test, and a decreased functioning of the flow along the anterior communicating artery when the common carotid was compressed. During the later phases of the 30-day long AO, these blood flow indices tended to return to normal. In dogs, the AO led to a sharp increase in pressure in the jugular veins and in peripherals of the carotid pool, and to a decrease of blood flow rate in the carotid arteries. IAA

**N87-30044#** Joint Publications Research Service, Arlington, Va.
**HEMODYNAMIC EFFECTS OF NEGATIVE PRESSURE IN LOWER BODY Abstract Only**
M. M. Mirrakhimov, T. A. Azhimamatov, and T. B. Baltabayev *In its* USSR Report: Life Sciences. Biomedical and Behavioral Sciences 29 Apr. 1987 p 2 Transl. into ENGLISH from Fiziologiya Cheloveka (Moscow, USSR), v. 11, no. 5, Sep. - Oct. 1985 p 763-769 Original language document was announced in IAA asA86-15514 (For primary document see N87-30042 24-52)
Avail: NTIS HC A05/MF A01

The effect of lower body negative pressure (LBNP) on the cardiovascular functions was studied in 42 normal male subjects aged 31-64 yrs, using noninvasive methods of electrocardiography, phonocardiography, and tetrapolar thoracic rheography. The responses to the LBNP included increases in heart rate and in systemic vascular pressure, decreases in the heart rate and the cardiac indices as well as in the volumes of the cardiac chambers, caused by partial detainment of blood in the large-capacity blood vessels of the lower body. The degree of these changes depended on the magnitude of applied LBNP, which was in the range of 20-60 mm. Rapid (2-3 sec) decompression caused the temporarily detained blood to enter the circulation, leading to short-term increases of the cardiac volume load and to reversal of the hemodynamic effects caused by the LBNP. IAA

**N87-30045#** Joint Publications Research Service, Arlington, Va.
**INTERACTION OF MACULA AND SEMICIRCULAR CANALS IN ANGULAR STABILIZATION OF MAN IN SPACE Abstract Only**
V. M. Gusev and V. A. Kislyakov *In its* USSR Report: Life Sciences. Biomedical and Behavioral Sciences 29 Apr. 1987 p 2-3 Transl. into ENGLISH from Biofizika (Moscow, USSR), v. 31, no. 1, Jan. - Feb. 1986 p 123-127 Original language document was announced in IAA as A86-27474 (For primary document see N87-30042 24-52)
Avail: NTIS HC A05/MF A01

A mathematical model is developed for spatial angular stabilization in which the fixed and variable space coordinates are related to the coordinates of the semicircular canals and the otolithic organ during spatial displacement. The equations describing the interrelationship of both vestibular systems are solved for the case of abrupt displacement of angular vectors, and for the case of slow periodic variations of the same angles, approximating the pitching and rocking motion of a medium-size fishing trawler. The results indicate a need for integrated activity of both the semicircular canals and the otolithic organ for an acceptable stabilization: the canals insure short-term stabilization and stabilization during the abrupt changes of spatial orientation, while the otolithic organ plays a dominant role during long-term slowly occurring changes. IAA

**N87-30046#** Ministry of Defence, Tel-Aviv (Israel). Directorate of Defence R and D.
**ADJUSTMENT AND VALIDATION OF THE MATHEMATICAL PREDICTION MODEL FOR SWEAT RATE, HEART RATE AND BODY TEMPERATURE UNDER OUTDOOR CONDITIONS Annual Report, 7 Oct. 1985 - 6 Oct. 1986**
Y. Shapiro, R. Burstein, and Y. Epstein 1 Nov. 1986 17 p
(Grant DAMD17-85-G-5044)
(AD-A183109) Avail: NTIS HC A02/MF A01 CSCL 06J

This study is conducted in order to validate under outdoor conditions, and if necessary, to adjust the mathematical models to predict physiological tolerance under different environmental conditions, solar loads, clothing ensembles, and metabolic rates. Different physiological parameters were carefully monitored. The results show that the prediction models, which were developed from laboratory studies, are conservative and overestimate the physiological responses under outdoor conditions. It is hypothesized that a factor related to long wave radiations should be included in the equations. GRA

**N87-30047#** School of Aerospace Medicine, Brooks AFB, Tex.
**SPATIAL ORIENTATION IN FLIGHT Final Report, Jan. 1982 - Jan. 1985**
Kent K. Gillingham and James W. Wolfe Dec. 1986 133 p
(AD-A183431; USAFSAM-TR-85-31) Avail: NTIS HC A07/MF A01 CSCL 06J

Man's orientational mechanisms, and how those mechanisms fail in flight, are discussed in this comprehensive review. Specific topics include: Mechanics and associated physiologic nomenclature; visual orientation; vestibular function and information processing; other senses of motion and position; spatial disorientation, including causes, types, examples, statistics, and methods of preventing orientation mishaps; and the significance, etiology, and therapy of motion sickness. Forty-three figures are included, many illustrating vestibular anatomy and physiology, and others depicting the more common visual and vestibular illusions in flight. Sixty-five classic references and a recommended reading list are also provided. GRA

**N87-30048#** Naval Aerospace Medical Research Lab., Pensacola, Fla.
**NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY BIBLIOGRAPHY, 1981-1986 Interim Report, 1 Jan. 1981 - 31 Dec. 1986**
Kathleen S. Mayer Jun. 1987 21 p
(AD-A183837) Avail: NTIS HC A02/MF A01 CSCL 06E

This report lists citations of all unclassified research reports, special reports, monographs, journal articles, and proceedings that were published by the Naval Aerospace Medical Research Laboratory during calendar years 1981 through 1986. Requests for numbered reports (AD XXX XXX) should be directed to DTIC, Cameron Station, Alexandria, Virginia 22314. Requests for articles that were published in the open literature should be addressed to the author, NAMRL, NAS, Pensacola, Florida 32508-5700. GRA

**N87-30049*#** Good Samaritan Hospital and Medical Center, Portland, Oreg. Neurological Sciences Inst.
**ROLE OF ORIENTATION REFERENCE SELECTION IN MOTION SICKNESS, SUPPLEMENT 2S Semiannual Status Report**
Robert J. Peterka and F. Owen Black Oct. 1987 16 p
(Grant NAG9-117)
(NASA-CR-181393; NAS 1.26:181393) Avail: NTIS HC A02/MF A01 CSCL 06P

Previous experiments with moving platform posturography have shown that different people have varying abilities to resolve conflicts among vestibular, visual, and proprioceptive sensory signals. The conceptual basis of the present proposal hinges on the similarities between the space motion sickness problem and the sensory orientation reference selection problems associated with benign paroxysmal positional vertigo (BPPV) syndrome. These similarities include both etiology related to abnormal vertical canal-otolith function, and motion sickness initiating events provoked by pitch and roll head movements. The objectives are to explore and quantify the orientation reference selection abilities of subjects and the relation of this selection to motion sickness in humans. The overall objectives are to determine: if motion sickness susceptibility is related to sensory orientation reference selection abilities of subjects; if abnormal vertical canal-otolith function is the source of abnormal posture control strategies and if it can be quantified by vestibular and oculomotor reflex measurements, and if it can be quantified by vestibular and oculomotor reflex measurements; and quantifiable measures of perception of vestibular and visual motion cues can be related to motion sickness susceptibility and to orientation reference selection ability. B.G.

**N87-30065#** Britannia Airways Ltd., Luton (England).
**IN-FLIGHT ASSESSMENT OF WORKLOAD USING PILOT RATINGS AND HEART RATE**
Alan H. Roscoe *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 78-82 (For primary document see N87-30054 24-54)
Copyright Avail: NTIS HC A07/MF A01

# 53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**N87-30050#** Air Force Human Resources Lab., Brooks AFB, Tex.
**SPATIAL ABILITY AS A PREDICTOR OF FLIGHT TRAINING PERFORMANCE Interim Report, Jan. 1982 - Sep. 1986**
Thomas R. Carretta Jul. 1987 15 p
(AD-A183141; AFHRL-TP-86-70) Avail: NTIS HC A02/MF A01 CSCL 05I

Spatial ability has been demonstrated to be related to performance of a variety of tasks including several military enlisted jobs and piloting aircraft. This paper examined the relationship between performance on spatial ability task (i.e., the Mental Rotation Test) and flight training performance for 1,939 United States Air Force Undergraduate Pilot Training (UPT) candidates. Performance on the Mental Rotation Test was not related to completion of training, but was related to a recommendation for specialized training after UPT. Pilot candidates who made quick, consistent, and accurate judgements were more likely to be recommended for fast-jet training (Fighter-Attack-Reconnaissance or FAR). This was consistent with the current practice of selecting the best-performing student pilots for follow-on training in FAR aircraft. GRA

**N87-30051#** Naval Aerospace Medical Research Lab., Pensacola, Fla.
**TRACKING A LASER-PROJECTED HORIZON INDICATOR Interim Report**
J. M. Lentz, G. T. Turnipseed, and W. C. Hixson May 1987 20 p
(AD-A183384; NAMRL-1330) Avail: NTIS HC A02/MF A01 CSCL 01D

We did not evolve in motion and acceleration environments typical of military aviation, and we lack sense organs to cope with these environments. Even though the vestibular and visual system function properly in these environments, the brain accurately interprets them without visual or tactile contact with some fixed spatial reference point such as the Earth's horizon. In the airplane, this reference is provided by a gyro-stabilized artificial horizon instrument. Individuals differ widely in their ability to extract visual information from this attitude indicator and mentally integrate it with information from other body sensors. Consequently, failure to assimilate all of this information can result in disorientation, erratic motor performance, or intuitively correct but grossly incorrect control decisions. One of the more promising recent attempts to combat inflight spatial disorientation has focused on the development of Peripheral Vision Horizon Devices (PVHD) suitable for installation in operational aircraft. This paper describes a series of laboratory experiments directed at explaining some of the psychophysiological characteristics of the PVHD significant to its operational application. GRA

**N87-30052#** Letterman Army Inst. of Research, San Francisco, Calif.
**VISUAL INPUT REQUIREMENTS RELATING TO PURSUIT TRACKING ACCURACY Report, Feb. 1985 - Jun. 1986**
Kenneth R. Bloom and Harry Zwick Jun. 1987 23 p
(AD-A183445; LAIR-241) Avail: NTIS HC A02/MF A01 CSCL 05A

The interaction between visual function and pursuit tracking performance was measured in 10 human volunteers who participated in three daily 1-hr sessions involving two target sizes (18 min arc and 6 min arc - 1 min arc = 0.28 mrad), two target intensities (photopic = 25 cd/sq m, mesopic = .76 cd/sq m, and two directions of horizontal target motion. Pursuit tracking performance was measured by a computerized video digitizing system, developed at LAIR, during 20-sec tracking trials. Analysis of variance showed significant main effects for target luminance and under mesopic target conditions, target size on pursuit tracking accuracy, pointing to the need to delineate the visual requirements of visual motor tasks to assess the effects of battlefield laser exposure. GRA

**N87-30053#** Georgia Inst. of Tech., Atlanta. Systems Engineering Lab.
**ENHANCEMENT OF HUMAN PERFORMANCE IN MANUAL TARGET ACQUISITION AND TRACKING Final Report, Dec. 1984 - Feb. 1986**
Dennis J. Folds, Jeffrey M. Gerth, and William R. Engelman May 1987 48 p
(Contract F33615-83-D-0601)
(AD-A183549; USAFSAM-TR-86-18) Avail: NTIS HC A03/MF A01 CSCL 05I

A review and analysis of the literature pertaining to human performance in manual target acquisition and tracking tasks is presented. The emphasis is on the identification of factors which enhance performance, particularly those related to training and practice. Three major areas are reviewed: (1) typical patterns of performance in simple target acquisition and tracking tasks; (2) the effects of various training and practice regiments on the development of tracking proficiency; and (3) the impact of dual-task conditions on performance of tracking tasks. A framework for interpreting the various theoretical constructs and empirical findings covered in the literature is offered. This framework is based on the general notion of response organization, and embraces both the process of organization and the result of that process. A major issue which has not been addressed in the literature is how the impact of dual-task conditions on response organization may be lessened (or recovery hastened) by appropriate training. An experiment was conducted to address this issue. GRA

**N87-29505#** Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France).
**STUDY OF ANTICIPATION MECHANISMS IN THE AERONAUTICAL ENVIRONMENT [ETUDE DES MECANISMES D'ANTICIPATION EN AERONAUTIQUE]**
R. Amalberti, Cl. Valot, and J.-P. Menu *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 14 p In FRENCH (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29506#** Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Helicopter and Military Aircraft Group.
**THE TASK TAXONOMY METHOD: A BASIS FOR AN EXPERT SYSTEM ON HUMAN RELIABILITY**
R. Seifert and K. Brauser *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 8 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-30060#** McDonnell-Douglas Corp., Long Beach, Calif.
**MENTAL WORKLOAD MEASUREMENT IN OPERATIONAL AIRCRAFT SYSTEMS: TWO PROMISING APPROACHES**
Michael Biferno *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 44-51 (For primary document see N87-30054 24-54)
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# 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

**N87-30054#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
**THE PRACTICAL ASSESSMENT OF PILOT WORKLOAD**
Alan H. Roscoe, ed. (Britannia Airways Ltd., Luton, England ) Jun. 1987 141 p
(AGARD-AG-282; ISBN-92-835-1546-3) Copyright Avail: NTIS HC A07/MF A01

Whether one is attempting to reduce workload in the cockpit of a combat aircraft to improve mission effectiveness, or to optimise workload levels on the flight deck of a civil airliner to improve safety, it is important to be able to assess workload in practical terms. In the case of the civil transport aircraft the findings of the President's Task Force on Crew Complement have underlined the need to assess workload in flight reliably in order to satisfy certification requirements for new aircraft. The main purpose of this report is to provide guidance for the assessment of pilot workload in practical situations. The various techniques available for assessing pilot workload are introduced and briefly reviewed. Some techniques that have been successful inflight are presented along with techniques for assessing workload for the purpose of aircraft certification. For individual titles, see N87-30055 through N87-30069.

**N87-30055#** Ergometrics Technology, Inc., Dayton, Ohio.
**IN-FLIGHT WORKLOAD ASSESSMENT USING EMBEDDED SECONDARY RADIO COMMUNICATIONS TASKS**
Clark A. Shingledecker *In* Advisory Group for Aerospace Research and the Practical Assessment of Pilot Workload Jun. 1987 p 11-14 (For primary document see N87-30054 24-54)
Copyright Avail: NTIS HC A07/MF A01

The embedded secondary task methodology was developed to improve the practical utility of dual task measures for inflight workload assessment, while retaining many of the scientific advantages associated with traditional laboratory secondary tasks. The concept of the embedded secondary task is based on the hypothesis that instrumentation limitations, task intrusion, and poor operator acceptance can be minimized by designing secondary tasks which are fully integrated with system hardware and with the crewmember's conception of the mission environment. By their nature, such tasks are realistic components of crewstation activity, yet their performance can be manipulated and measured independently of the primary activities of interest. While several classes of aircrew activity are potential candidates for isolation and use as embedded tasks, radio communication tasks are particularly suitable for this purpose. Such tasks closely resemble the nonadaptive discrete secondary tasks used in numerous workload studies and have many properties of good measurement tasks. Measurement techniques are described and examples of use are given along with limitations. Author

**N87-30056#** Douglas Aircraft Co., Inc., Long Beach, Calif.
**USE OF TASK TIMELINE ANALYSIS TO ASSESS CREW WORKLOAD**
G. Stone, R. K. Gulick, and R. F. Gabriel *In* Advisory Group for Aerospace Research and the Practical Assessment of Pilot Workload Jun. 1987 p 15-31 (For primary document see N87-30054 24-54)
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As systems have become more sophisticated, the role of humans in operating and maintaining them has grown more complex. There has been a steadily growing recognition that human characteristics, particularly limitations and abilities, must be considered in some depth in system design if design objectives are to be met. The size and role of the crew represent critical decisions. Mission performance has a direct relationship to the ability of the crew to carry out all of the required functions. The use of workload measures to assess the viability of a selected crew complement as well as other crew interfaces was considered. Several techniques are listed which are used to assess workload including task/timeline analysis measures. It appears to be the most easily implemented and could meet most of the established criteria. A model was developed to utilize this workload measure in the design, verification of design improvements, and certification of recent aircraft. This approach is presented and discussed in detail. E.R.

**N87-30057#** Boeing Co., Seattle, Wash.
**PILOT SUBJECTIVE EVALUATION OF WORKLOAD DURING A FLIGHT TEST CERTIFICATION PROGRAMME**
Frank T. Ruggiero and Delmar M. Fadden *In* advisory Group for Aerospace Research and the Practical Assessment of Pilot Workload Jun. 1987 p 32-36 (For primary document see N87-30054 24-54)
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To date there is no agreed upon definition of mental workload and therefore there is no agreement on how it should be measured. Three aspects of mental workload are agreed upon: it is a multidimensional construct, a clear distinction must be maintained between imposed mental load (task load) and the mental load as experienced (subjective load), and the use of subjective ratings should be central to any investigation of workload. The Pilot Subjective Evaluation (PSE) process developed in conjunction with the FAA is outlined which supplements the analytical, simulator, and flight test crew workload evaluation techniques used to demonstrate compliance with the minimum crew size requirement regulations. Author

**N87-30058#** Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. for Flight Guidance.
**THE USE OF SUBJECTIVE WORKLOAD ASSESSMENT TECHNIQUE IN A COMPLEX FLIGHT TASK**
F. V. Schick and R. L. Hann (Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.) *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 37-41 (For primary document see N87-30054 24-54)
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Techniques for measuring mental workload can be divided into three basic categories: physiological, behavioral, and subjective. One particular technique belonging to the subjective group of methods, which always use some form of operator self-report (e.g., rating scales or questionnaires) is discussed. In order to deal with the undesirable properties of subjective methods, a procedure known as the Subjective Workload Assessment Technique (SWAT) was developed. In SWAT, subjective workload is defined as being composed of three dimensions: time load, mental effort load, and psychological stress load. This method is introduced and discussed. E.R.

**N87-30059#** Illinois Univ., Urbana-Champaign. Dept. of Psychology.
**WORKLOAD METHODOLOGY**
Emanuel Donchin and Christopher D. Wickens *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 42-43 (For primary document see N87-30054 24-54)
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The goal of the proposed technique is to employ two converging methodologies to track the workload changes during the ILS approach to landing. The two methodologies, based upon the Event Related Brain Potential (ERP) and the Sternberg Memory Search task, provides information that is both sensitive, detecting variations in resource demand when they occur, and diagnostic, localizing these changes within the multidimensional space underlying human processing resources. Each of these techniqes are briefly described. The ERP is a transient series of voltage oscillations in the brain that can be recorded from the scalp in response to the occurrence of a discrete event. The Sternberg Memory Search requires the pilot to identify whether or not a displayed character is one of a set of characters that is held in short term memory. Author

**N87-30060#** McDonnell-Douglas Corp., Long Beach, Calif.
**MENTAL WORKLOAD MEASUREMENT IN OPERATIONAL AIRCRAFT SYSTEMS: TWO PROMISING APPROACHES** c53
Michael Biferno *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 44-51 (For primary document see N87-30054 24-54)
Copyright Avail: NTIS HC A07/MF A01

When evaluating aircraft systems, the most useful mental workload (MWL) measures are those which can be employed inflight or full mission simulations. This requires measures to be noninterfering, relatively unobtrusive, and provide estimates of operationally relevant MWL while maintaining high levels of validity and reliability. In the context of automated systems, the strategy was to define MWL as language based mental activity and to develop subjective ratings (opinion scale) in the short term and event related brain potential (ERP) measures in the long term. Subjective ratings are being employed to estimate the required degree of attention to perform: information processing, mental operations, and actions. This organization aids in the identification of undesirable MWL levels associated with system displays, logic, and controls. In addition to providing a quantitative workload rating, this technique elicits verbal explanations if high MWL levels are reported. Author

**N87-30061#** Ergometrics Technology, Inc., Dayton, Ohio.
**CORTICAL EVOKED RESPONSE AND EYEBLINK MEASURES IN THE WORKLOAD EVALUATION OF ALTERNATIVE LANDING SYSTEM DISPLAYS**
R. D. ODonnell and Glenn Wilson *In* Advisory Group for Aerospace Research and the Practical Assessment of Pilot Workload Jun. 1987 p 52-55 Prepared in cooperation with Aerospace Research Labs., Wright-Patterson AFB, Ohio (For primary document see N87-30054 24-54)
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Based on the results of a number of studies, it was decided to construct a battery of physiological tests, each of which had shown some promise in laboratory studies of being sensitive to various aspects of workload. This Neuropsychological Workload Test Battery (NWTB) is undergoing validation testing in several simulator environments. Two of the most promising measures from this battery are the transient cortical evoked response and several analyses of eyeblink behavior. It is becoming clear that these techniques can contribute complementary types of information on the amount of workload being experienced by the operator, and could form the basis of a measurement system which would tap both global and specific aspects. Rationales are given for these techniques along with a description and examples of their use. E.R.

**N87-30062*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**IN-FLIGHT ASSESSMENT OF WORKLOAD USING INSTRUMENT SCAN**
J. R. Tole (Digital Analysis Corp., Reston, Va.) and R. L. Harris, Sr. *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 56-59 (For primary document see N87-30054 24-54)
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During instrument flight, the pilot obtains information concerning aircraft state by cross checking or scanning the flight instruments. The exact method of scanning the instrument panel varies from pilot to pilot but there are some basic features common to a good scan pattern. The method discussed may be considered a candidate for workload studies with piloting tasks which will invoke a regular visual scan (spatial/temporal pattern of eye movements) during instrument flight. It is important to point out that instrument scan by itself is not a complete indicator of workload nor is task attention necessarily associated with where the pilot happens to be looking at a particular instant. However, whenever instrument scan is required in a piloting task, analysis of scanning behavior may yield important direct or indirect information concerning workload. Author

**N87-30063#** British Aerospace Dynamics Group, Hatfield (England). Test Pilots Office.
**FLIGHT TEST EVALUATION OF CREW WORKLOAD. PART 1: AIRCRAFT CERTIFICATION FOR A MINIMUM CREW OF TWO PILOTS**
W. A. Wainwright *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 60-68 (For primary document see N87-30054 24-54)
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The method developed to certificate the BAe 146 for operation by a minimum crew of two pilots to regulations is described. The method is based primarily on subjective assessment of workload but employs objective data to support that assessment. All the data were collected from one flying phase and no flight or ground simulator assessments were performed, neither were the results correlated with any previous evaluation. The flight test evaluation used a variety of assessment methods, including practical demonstration, qualitative and quantative subjective evaluation, subjective comparison with similar aircraft types, and objective physiological evaluation. All confirmed that the crew workload on the BAe 146 was compatible with operation by a minimum crew of 2 pilots. This method is briefly discussed. Author

**N87-30064#** Royal Air Force Strike Command, High Wycombe (England).
**MEASUREMENT OF AIRCREW WORKLOAD DURING LOW-LEVEL FLIGHT. PART 1: A COMPARISON BETWEEN IN-FLIGHT AND POST FLIGHT ASSESSMENT METHODS**
I. Gavin Lidderdale *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 69-77 (For primary document see N87-30054 24-54)
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The results of a comparative study of the use of inflight and postflight methods of subjective workload assessments in a modern military combat aircraft are presented. The assessments were made during a demanding low level flight task which was undertaken to assess workload and define crew cooperation procedures for pilot and navigators during terrain following flight. The inflight workload assessments were made using a modified version of the Cooper-Harper scale which is referred to as the Bedford Scale. Postflight ratings were made using a method of pairwise comparisons based on a method reported by Saaty. Other measures, including physiological recordings and voice tapes were also taken during the trials to provide additional data. From the results of the trials, it was found that both methods of subjective workload assessment produced similar results and a rank order analysis gave high correlations. A hypothetical Recce/Attack task for fast jet aircraft was chosen to illustrate the application of the workload measurement techniques described. The technique relies on the use of subjective ratings scales and physiological measures supported by voice recordings and flight data recordings. Author

**N87-30065#** Britannia Airways Ltd., Luton (England).
**IN-FLIGHT ASSESSMENT OF WORKLOAD USING PILOT RATINGS AND HEART RATE** **c52**
Alan H. Roscoe *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 78-82 (For primary document see N87-30054 24-54)
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At present the most used and probably the most reliable methods for assessing pilot workload in flight are based on some form of subjective reporting by experienced test pilots. Subjective opinions are susceptible to bias and preconcieved ideas and so may occasionally result in false estimates of workload. For more than 15 years subjective reporting at RAE Bedford has been augmented by recording their heart rates. At first pilots described workload in a relatively unstructured manner but the need for some form of rating scale was soon apparent. After much trial and error, a 10 point rating scale using the concept of spare capacity was developed. The overall design is based on the Handling Qualities Rating Scale of Cooper and Harper. During the past 8 year a number of flight trials have used pilot ratings and heart rate responses to assess workload. The rationale for using heart rate in assessing pilot workload is based on the concept of neurological arousal. The technique is described and examples of its use are given. Also listed and briefly discussed are limitations and pitfalls of the technique. Author

**N87-30066#** Cranfield Inst. of Tech., Bedford (England). Applied Psychology Unit.
**THE ASSESSMENT OF WORKLOAD IN HELICOPTERS**
Helen C. Muir and Robert Elwell *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 83-89 (For primary document see N87-30054 24-54)
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In aviation an assessment of workload is often used as one component in a program of research. The objective of the research may vary from an assessment of the activities of the crew to an evaluation of either cockpit modifications or operational changes. Thus workload assessments will form one of a series of stages in the research. A model is presented in which the stages of the investigation which will proceed and follow the workload assessment are described. An application of this approach to the assessment of workload in helicopters is used to illustrate the practical implications of the model. Author

**N87-30067#** Airbus Industrie, Blagnac (France).
**ASSESSING WORKLOAD FOR MINIMUM CREW CERTIFICATION. PART 1: STATIC WORKLOAD ANALYSIS AND PERFORMANCE ANALYSIS**
J. J. Speyer, A. Fort, J. P. Fouillot, and R. D. Blomberg *In* Advisory Group for Aerospace Research and the Practical Assessment of Pilot Workload Jun. 1987 p 90-115 Prepared in cooperation with Centre de Recherches de Medecine Aeronautique, Paris (France) and Dunlap and Associates, Inc., Norwalk, Conn. (For primary document see N87-30054 24-54)
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The critical importance of man machine interaction has been recognized in the field of aircraft handling qualities. The recognition that man machine interaction is part of a complex information transfer process between pilots, the aircraft and ground facilities is relatively new. Classical are the systematic methods for assessing aircraft handling qualities, which inspired the approach to workload assessment presented. Also classical topics in flight test are the determination of static and dynamic stability, the former indicating the tendency of an aircraft to return to its equilibrium position, the latter indicating the way an aircraft returns to its equilibrium position. Analogous to the complementarity of these evaluations, the Static Taskload and the Dynamic Workload Methods were developed. Both methods address particular workload functions and factors. These methods are briefly described and discussed. Author

**N87-30068*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**MEASUREMENT OF PILOT WORKLOAD**
Sandra G. Hart *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 116-122 (For primary document see N87-30054 24-54)
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A multistage process for evaluating the workload of a five-minute segment of flight including approach and landing for a typical transport aircraft was described. The goal of the analysis was to compare the workload of the two pilots. Four types of measurement techniques were suggested: Analytic (a preliminary task and time line analysis identified task requirements and target performance levels); Performance (flight path control, communications, and interval production); Physiological (heart rate and heart rate variability); and Subjective ratings (a multidimensional technique developed at NASA Ames). Author

**N87-30069#** National Aerospace Lab., Amsterdam (Netherlands).
**INVESTIGATION OF WORKLOAD MEASURING TECHNIQUES: A THEORETICAL AND PRACTICAL FRAMEWORK**
Rene C. vandeGraaff *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload Jun. 1987 p 123-130 (For primary document see N87-30054 24-54)
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A number of considerations involved in the setting up of an investigation dealing with the problem of being able to draw conclusions from a variety of experimental measures in a complex task situation are discussed. Several implications are pointed out, such as the problem of dealing with contradictory outcomes, the designating of artefacts, and the problem of formulating final conclusions with the (a priori) availability of a superior method for evaluating other methods. An experimental program is outlined which is based on (normal) approach conditions for civil fixed wing aircraft. The task conditions in this experiment are selected to serve as an operationally based framework for comparing different workload evaluation methods, for evaluating the effects of specific task conditions and for investigating the strategies needed for drawing final conclusions from a variety of outcomes. Author

**N87-30070#** Oak Ridge National Lab., Tenn.
**DYNAMIC TASK ALLOCATION FOR A MAN-MACHINE SYMBIOTIC SYSTEM**
L. E. Parker and F. G. Pin Jun. 1987 55 p
(Contract DE-AC05-84OR-21400)
(DE87-011950; ORNL/TM-10397; CESAR-87/08) Avail: NTIS HC A04/MF A01

This report presents a methodological approach to the dynamic allocation of tasks in a man-machine symbiotic system in the context of dexterous manipulation and teleoperation. This report addresses a symbiotic system containing two symbiotic partners which work toward controlling a single manipulator arm for the execution of a series of sequential manipulation tasks. It is proposed that an automated task allocator use knowledge about the constraints/criteria of the problem, the available resources, the tasks to be performed, and the environment to dynamically allocate task recommendations for the man and the machine. The presentation of the methodology includes discussions concerning the interaction of the knowledge areas, the flow of control, the necessary communication links, and the replanning of the task allocation. Examples of task allocation are presented to illustrate the results of this methodology. DOE

**N87-30071#** Army Research Inst. of Environmental Medicine, Natick, Mass.
**EFFECTIVENESS OF AN AIR COOLED VEST USING SELECTED AIR TEMPERATURE, HUMIDITY AND AIR FLOW RATE, COMBINATIONS**
Stephen R. Muza, Nancy A. Pimental, and Henry M. Cosimini Jun. 1987 36 p
(AD-A183298; USARIEM-T-22-87) Avail: NTIS HC A03/MF A01 CSCL 05H

The effectiveness of reducing thermal strain in soldiers by supplying an air-cooled vest with each of four different dry bulb (db) and dew point (dp) temperatures and air combinations is evaluated. The four combinations were selected to determine minimal air conditioning requirements for several military vehicles. Six male soldiers attempted four, 300-min heat exposures (49 C db, 20 C dp) at metabolic rates of either 175 and 315 W. The soldiers wore chemical protective clothing over the combat vehicle crewman uniform and the air-cooled vest. Air supplied to the vest ranged from 22.5 to 27.5 C db, 15.5 to 21.1 dp at flow rates of either 10 or 14.5 cfm. Endurance times with the vest were 272 to 300 min (175 W) and 159 to 220 min (315 W). In summary, at the 175 W metabolic rate the vest condition which provided the 10 cfm air flow was effective in reducing thermal strain and extending endurance time. At the 315 W metabolic rate, typical of a tank commander or loader, either vest condition would extend endurance time, but would not be as effective in reducing thermal strain as the vest combinations tested in an earlier study. GRA

**N87-30072#** Naval Aerospace Medical Research Lab., Pensacola, Fla.
**INCOMPATIBILITY OF THE M-1 MANEUVER WITH US NAVY TACTICAL AIRCRAFT OXYGEN SYSTEMS Final Report**
J. T. White and L. M. Morin Sep. 1986 9 p
(AD-A183731; NAMRL-TM-86-1) Avail: NTIS HC A02/MF A01 CSCL 06J

A spectrum of clinical symptoms consisting of grey-out, black-out, and G-induced loss of consciousness has been identified in pilots of high performance aircraft. The M-1 maneuver used in conjunction with reclined seats and inflated G-suit provides significant protection against these symptoms. Centrifuge-trained United States Navy tactical aircraft pilots have recently reported a decreased ability to perform the M-1 maneuver while using the MBU-12P oxygen mask and CRU-79/P oxygen regulator. This report reviewed the performance specifications of these devices and compared them with published pulmonary flow rates. We found this oxygen system to interfere with the performance of the M-1 and other anti-G maneuvers. Further research is needed to characterize pulmonary flow rates during the performance of the M-1 maneuver in order to make recommendations for breathing system standards aboard high performance aircraft. GRA

**N87-29504#** Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
**AUTOMATION AT THE MAN-MACHINE INTERFACE**
Walter M. Hollister *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems (date) 10 p(SEE N87-29503 24-06) Feb. 1987 (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29507#** Washington Univ., St. Louis, Mo.
**CLOSING THE MAN-MACHINE LOOP: ON THE USE OF PHYSIOLOGICAL MEASURES TO AFFECT COMPUTER-CONTROLLED DEVICES**
J. A. Stern, G. F. Wilson, and M. Theissen (General Dynamics Corp., Fort Worth, Tex.) *In* AGARD, Information Management

and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 5 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29508*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**THE EFFECTS OF DISPLAY-CONTROL I/O, COMPATIBILITY, AND INTEGRALITY ON DUAL-TASK PERFORMANCE AND SUBJECTIVE WORKLOAD**
Pamela S. Tsang (Illinois Univ., Savoy.), Sandra G. Hart, and Michael A. Vidulich *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 9 p (For primary document see N87-29503 24-06)
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**N87-29509#** Royal Air Force, London (England).
**A STUDY OF PILOT FLIGHT INFORMATION CROSSMONITORING PERFORMANCE**
V. P. Schmit *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29510#** Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France).
**SOPHISTICATED INTEGRAL CONTROL METHODS FOR USE IN FLIGHT [LES MOYENS DE COMMANDE INTEGRES SOPHISTIQUES SERONT-ILS CONCUS POUR ETRE UTILISABLES EN VOL]**
J.-P. Menu, G. Santucci, and R. Amalberti *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 6 p In FRENCH (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29516#** Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France). Lab. Central de Biologie Aerospatiale.
**ORGANIZATION OF DISPLAYS IN THE VISUAL SPACE OF THE COMBAT AIRCRAFT PILOT [ORGANISATION DES VISUALISATIONS DANS L'ESPACE VISUEL DU PILOTE D'AVION DE COMBAT]**
J.-P. Menu and R. Amalberti *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p In FRENCH (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29865*#** Rockwell International Corp., Downey, Calif. Space Station Systems Div.
**THE DESIGN AND DEVELOPMENT OF A MOBILE TRANSPORTER SYSTEM FOR THE SPACE STATION REMOTE MANIPULATOR SYSTEM**
Thomas W. Carroll *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 93-101 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 05H

**N87-29866*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**TELEROBOTIC WORK SYSTEM: CONCEPT DEVELOPMENT AND EVOLUTION**
Lyle M. Jenkins *In its* The 21st Aerospace Mechanisms Symposium May 1987 p 103-110 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 05H

**N87-29867*#** Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn.
**TRACTION-DRIVE, SEVEN-DEGREE-OF-FREEDOM TELEROBOT ARM: A CONCEPT FOR MANIPULATION IN SPACE SPACE**
D. P. Kuban and D. M. Williams *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium May 1987 p 111-130 (For primary document see N87-29858 24-39)
Avail: NTIS HC A16/MF A01 CSCL 05H

# 55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

# 59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

No abstracts in this category.

# 60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

**N87-30073*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**PERFORMANCE OF FORTRAN FLOATING-POINT OPERATIONS ON THE FLEX/32 MULTICOMPUTER Final Report**
Thomas W. Crockett Aug. 1987 11 p
(Contract NAS1-18107)
(NASA-CR-178364; ICASE-IR-4; NAS 1.26:178364) Avail: NTIS HC A02/MF A01 CSCL 09B

A series of experiments has been run to examine the floating-point performance of FORTRAN programs on the Flex/32 (Trademark) computer. The experiments are described, and the timing results are presented. The time required to execute a floating-point operation is found to vary considerbaly depending on a number of factors. One factor of particular interest from an algorithm design standpoint is the difference in speed between common memory accesses and local memory accesses. Common memory accesses were found to be slower, and guidelines are given for determinig when it may be cost effective to copy data from common to local memory. Author

**N87-29520#** Naval Ocean Systems Center, San Diego, Calif.
**RAPID PROTOTYPING OF USER-COMPUTER INTERFACES DURING SYSTEM DESIGN**
G. A. Osga *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 10 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

# 61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

**N87-30074#** Los Alamos National Lab., N. Mex.
**EXPERIENCES AND RESULTS MULTITASKING A HYDRODYNAMICS CODE ON GLOBAL AND LOCAL MEMORY MACHINES**
David A. Mandell 1987 16 p Presented at the International Conference on Parallel Processing, St. Charles, Ill., 17-21 Aug. 1987
(Contract W-7405-eng-36)
(DE87-003759; LA-UR-86-4356; CONF-870831-1) Avail: NTIS HC A02/MF A01

A one-dimensional, time-dependent Lagrangian hydrodynamics code using a Godunov solution method has been multitasked for the Cray X-MP/48, the Intel iPSC hypercube, the Alliant FX series and the IBM RP3 computers. Actual multitasking results have been obtained for the Cray, Intel and Alliant computers and simulated results were obtained for the Cray and RP3 machines. The differences in the methods required to multitask on each of the machines is discussed. Results are presented for a sample problem involving a shock wave moving down a channel. Comparisons are made between theoretical speedups, predicted by Amdahl's law, and the actual speedups obtained. The problems of debugging on the different machines are also described. DOE

**N87-30075#** Lawrence Livermore National Lab., Calif.
**A SYSTOLIC ARRAY FOR EFFICIENT MATRIX-MATRIX MULTIPLICATION**
A. J. DeGroot, E. M. Johansson, and S. R. Parker Mar. 1987 17 p Presented at the International Conference on Parallel Processing, St. Charles, Ill., 17 Aug. 1987
(Contract W-7405-eng-48)
(DE87-007448; UCRL-96033-Rev-1; CONF-870831-2-Rev-1)
Avail: NTIS MF A01

The Systolic Processor with a Reconfigurable Interconnection Network of Transputers (SPRINT) is a sixty-four-processor multiprocessor developed at Lawrence Livermore National Laboratory for experimentally evaluating systolic algorithms and architectures. Its computation capabilities surpass its communication capabilities. Techniques have been developed to perform matrix-matrix multiplication utilizing most of its computing capability by operating on block matrices. These techniques reduce communication bandwidth requirements for a given computation rate. Using these techniques, processor efficiencies can approach 1. Previous techniques resulted in processor efficiency of 1/3. The algorithms are executed on the SPRINT to compare theory with experiment. DOE

**N87-30076*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**GRID GENERATION FOR THE SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS Final Report**
Peter R. Eiseman (Columbia Univ., New York, N.Y.) and Gordon Erlebacher Aug. 1987 89 p Submitted for publication
(Contract NAS1-18107)
(NASA-CR-178365; ICASE-87-57; NAS 1.26:178365) Avail: NTIS HC A05/MF A01 CSCL 09B

A general survey of grid generators is presented with a concern for understanding why grids are necessary, how they are applied, and how they are generated. After an examination of the need for meshes, the overall applications setting is established with a categorization of the various connectivity patterns. This is split between structured grids and unstructured meshes. Altogether, the categorization establishes the foundation upon which grid generation techniques are developed. The two primary categories are algebraic techniques and partial differential equation techniques. These are each split into basic parts, and accordingly are individually examined in some detail. In the process, the interrelations between the various parts are accented. From the established background in the primary techniques, consideration is shifted to the topic of interactive grid generation and then to adaptive meshes. The setting for adaptivity is established with a suitable means to monitor severe solution behavior. Adaptive grids are considered first and are followed by adaptive triangular meshes. Then the consideration shifts to the temporal coupling between grid generators and PDE-solvers. To conclude, a reflection upon the discussion, herein, is given. Author

**N87-30077** CIAD, Zoetermeer (Netherlands).
**SYSTEMS TESTING OF REGMA BRUNING ED 2 [SYSTEEMTEST REGMA BRUNING ED 2]**
P. vanSchaik and J. J. Duivenvoorden 1986 18 p In DUTCH
(CIAD-A-16; B8677767; ISBN-90-6818-020-7; ETN-87-90190)
Copyright Avail: Issuing Activity

The CAD SYSTEM Regma Bruning ED2 was tested. The different configurations of the systems, the components to be tested, and the testing configuration are described. Strong points of the system are: two-dimensional (2D) drawings (standard drawing functions); scaling of the drawings; modifications in the drawing whereby the scales are also changed; speed (in 2D). The weak points are: nonstandard drawing functions; and limited number of drawing options which can be defined by the user (line typing, text). ESA

**N87-30078** CIAD, Zoetermeer (Netherlands).
**SYSTEM TESTING OF THE CASCADE X DESIGNER [SYSTEEMTEST: CASCADE X DESIGNER]**
C. Tjallema and J. J. Duivenvoorden Aug. 1986 35 p In DUTCH
(CIAD-A-17; B8677768; ISBN-90-6818-026-6; ETN-87-90191)
Copyright Avail: Issuing Activity

The CAD two-dimensional drawing system Cascade X Designer was tested. The hardware and software of the Cascade system are described. The testing configuration and the functions to be tested, are presented. The advantages of the system are: well-organized control structure; short response time; clear screen; well-tested software; and customer supports. The disadvantages are: single-tasking operating system; very small and little interactive data base management system; operator's attention divided over console and two display units. ESA

**N87-30079** CIAD, Zoetermeer (Netherlands).
**GLOSSARY OF INDUSTRIAL AUTOMATION [WOORDENLIJST INDUSTRIELE AUTOMATISERING]**
Aug. 1986 28 p In DUTCH
(CIAD-D-1; B8677767; ISBN-90-6818-025-8; ETN-87-90192)
Copyright Avail: Issuing Activity

A summary in Dutch of the most important concepts and expressions in the field of computer aided design/computer aided manufacturing is presented. ESA

**N87-30080#** Kernforschungszentrum, Karlsruhe (West Germany).
**DEVELOPMENT OF THE PROCESS DATA HIGHWAY BUS PVD AND ITS COMPONENTS**
T. Pfeifer, W. Ruehle, and H. J. Venderbosch (Technische Hochschule, Aachen, West Germany ) Oct. 1986 228 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie, West Germany
(KfK-PFT-115; F41.644;AC-PFE/2; ETN-87-90348) Avail: NTIS HC A11/MF A01

An optionally centralized or decentralized bus system was developed. Based on requirements for advanced manufacturing technology, the structure and architecture of data transmission systems were theoretically studied. Hardware and software components for the elaborated system approach PVD-net were developed. The vendor-independent coupling of control elements requires appropriate standardized components which are not yet available. Possible PVD-net applications are given. ESA

**N87-30081#** Institute for Defense Analyses, Alexandria, Va.
**PRELIMINARY VERSION: ADA (TRADE NAME)/SQL: A STANDARD, PORTABLE ADA-DBMS INTERFACE Final Report**
Bill R. Brykczynski and Fred Friedman Apr. 1987 232 p
(Contract MDA903-84-C-0031)
(AD-A182885; AD-E500880; IDA-P-1944; IDA/HQ-86-31239)
Avail: NTIS HC A11/MF A01 CSCL 09B

This IDA Paper describes the standards and software developed that have addressed the area of interfacing with the database management systems(DBMS). A standard DBMS interface has been developed, consisting of both a data definition language and a data manipulation language(DML). Use of this standard within application programs will permit them to operate transportably with any variety of commercial off the shelf (COTS) DBMS. In addition, tools have been developed to assist in the implementation of the standard with a new COTS DBMS, and to automatically generate test data for use during the system checkout and tuning phases. Ada/SQL is a binding of the proposed ANSI standard database language SQL to the Ada programming language. This binding is currently being proposed as both an ANSI and ISO standard. Ada/SQL adheres to the current version of the proposed ANSI standard for SQL as much as possible. The underlying DBMS need not, however, conform to the SQL standard; the Ada/SQL environment translates between the standard Ada/SQL interface and that of the underlying DBMS. GRA

**N87-30082#** Carnegie-Mellon Univ., Pittsburgh, Pa. Software Engineering Inst.
**CHARACTERIZING THE SOFTWARE PROCESS: A MATURITY FRAMEWORK Final Report**
Watts S. Humphrey Jun. 1987 16 p
(Contract F19628-85-C-0003)
(AD-A182895; CMU/SEI-87-TR-11; ESD-TR-87-112) Avail: NTIS HC A02/MF A01 CSCL 09B

Improvement in the performance of software development organizations is an essential national need. The improvement process has five basic elements: (1) an understanding of the current status of the development process, (2) a vision of the desired process, (3) a prioritized list of required improvements actions, (4) a plan to accomplish these actions and (5) the resources andcommittment to execute the plan. This paper addresses the first three of these elements, by providing a model for software organizational improvement. The structure of this model provides five maturity levels, identifies the key improvements required at each level, and establishes a priority order for implementation. This model has been tested with a number of organizations and represented reasonably the status and needs of actual software development groups. GRA

**N87-30083#** California Univ., Berkeley. Inst. of Mathematical Sciences Research.
**PARALLEL AND DISTRIBUTED COMPUTING Final Report, 1 Jun. 1985 - 30 Nov. 1986**
I. Kaplansky and Richard M. Karp 11 Dec. 1986 16 p Presented at a workshop on Complexity of Parallel and Distributed Computing, Berkeley, Calif., 19-23 May 1986
(Grant AF-AFOSR-0203-85)
(AD-A182935; AFOSR-87-0899TR) Avail: NTIS HC A02/MF A01 CSCL 09B

A workshop was conducted on the complexity of parallel and distributed computation in May 1986. It had 21 speakers and 141 participants; their interests ranged from practical questions about the architecture of parallel and distributed systems to highly theoretical questions about the complexity of parallel computation. A panel discussion was held on the topic, Bridging the Gap Between Theory and Practice of Parallel and Distributed Computing. The main focus of the workshop was a set of mathematical and algorithmic issues that underlie the efficient use of the massively parallel computers that are just beginning to come into use. Several of the lectures were concerned with efficient algorithms for such computers. Other lectures were concerned with the problems of synchronization, load-sharing, and communication between processors in such systems. A third major theme was the reliable operation of such systems in the presence of faulty processors. GRA

**N87-30084#** Maryland Univ., College Park. Dept. of Computer Science.
**PROGRAMMING LANGUAGES AND SOFTWARE ENGINEERING Final Report, 1 Jan. 1985 - 28 Feb. 1987**
Victor R. Basili, John D. Gannon, and Marvin V. Zelkowitz 30 Apr. 1987 14 p
(Contract F49620-85-K-0008)
(AD-A183060; AFOSR-87-0930TR) Avail: NTIS HC A02/MF A01 CSCL 09B

Several issues critical to the improvement of software engineering techniques are discussed. A notion of abstraction for use in formal program specification was developed. A systematic way of building large programs by integrating reusable components was studied. An empirical study comparing the effects of three code reading techniques of three PASCAL programs seeded with different sets of faults was executed. Finally, in the area of advanced programming, improvements were made in the effectiveness of language-based environments, in the efficiency of language-based editors through the use of nonlocal productions, and in automatic inference of user data types. More than thirty published references and papers resulted from this effort. GRA

**N87-30085#** Massachusetts Inst. of Tech., Cambridge.
**SEQUENTIAL AND PARALLEL MATRIX COMPUTATIONS Final Report, Sep. 1983 - 30 Apr. 1987**
B. N. Datta 30 Apr. 1987 45 p
(Grant AF-AFOSR-0334-83)
(AD-A183160; AFOSR-87-0932TR) Avail: NTIS HC A03/MF A01 CSCL 09B

One major objective of the project entitled Sequential and Parallel Matrix Computations were to develop fast sequential and parallel matrix methods for a number of important linear algebraic problems that arise in design and analysis of linear control systems in state space form. Eighteen publications were accomplished during the cause of the grant, including such titles as, An algorithm to assign eigenvalues in a Hessenberg matrix, Sequential and parallel computations and complexities for determining relative primeness, stability, and inertia, and On finding eigenvalue distribution of a matrix in several regions of the complex plane. GRA

**N87-30086#** Columbia Univ., New York, N.Y.
**INVESTIGATION OF THREE-DIMENSIONAL MESH GENERATION WITH PRECISE CONTROLS Final Report, 1 May 1982 - 30 Sep. 1986**
Peter R. Eiseman 30 Sep. 1986 16 p
(Grant AF-AFOSR-0176-82)
(AD-A183161; AFOSR-87-0952TR) Avail: NTIS HC A02/MF A01 CSCL 09B

Progress was made in a number of topics including algebraic, adaptive, surface and interactive grid generation. Seventeen papers and one Ph.D. Thesis resulted, including such titles as Alternating Direction Adaptive Grid Generation, The Local Redistribution of Points along Curves for Numerical Grid Generation, Automatic Algebraic Coordinate Generation, and the Geometric Construction of Pointwise Distributions on Curves. In the first paper, an improvement was made for alternating direction adaptive grid generation method. In the second paper, a basic tool for interactive grid generation was developed from an earlier theory of weights. In the third paper, the basic formulations of algebraic transformation were extended by forming Boolean sums of multisurface transformation and, by appropriate caupositiars, lifting the results to curved 2-D surfaces. In the final referenced paper, the capability to accurately partition the available grid points among various properties was established along with the simultaneous specification of grid spacing from the boundaries. GRA

**N87-30087#** Stanford Univ., Calif. Systems Optimization Lab.
**THE BOX METHOD FOR LINEAR PROGRAMMING. PART 2: TREATMENT OF PROBLEMS IN STANDARD FORM WITH EXPLICITLY BOUNDED VARIABLES**
Karel Zikan and Richard W. Cottle Jul. 1987 15 p
(Contracts N00014-85-K-0343; DE-FG03-87ER-25028; Grant NSF DMS-84-20623)
(AD-A183217; SOL-87-9-Pt-2) Avail: NTIS HC A02/MF A01 CSCL 09B

A crucial aspect of the Box Method for linear programming is the finding of a minimum-weight basis corresponding to a given interior feasible point. This subproblem leads to the formation of the Box Problem, a special linear program having a closed form solution which provides the search direction at the current iteration. Finding a minimum-weight basis is a matroidal (combinatorial) optimization problem that can be handled by a greedy algorithm. This paper suggests a way to solve efficiently the minimum-weight basis problem in cases where the (primal, standard form) linear program contains explicitly bounded variables. It is shown that the main part of the task requires almost no more computational effort or storage space than does a problem of the same size without upper bounded variables. While this result is believed to be valuable in its own right, there is additional benefit to be gained in applications where the finding of a minimum-weight basis (for a linear program without explicit upper bounds on its variables) is done by a special greedy algorithm. Such is the case with minimum-cost network flow problems to be discussed in Part 3 of this series. GRA

**N87-30088#** Softech, Inc., Waltham, Mass.
**PROGRAM OFFICE GUIDE TO Ada, EDITION 1**
C. N. Ausnit, E. R. Ansarov, and N. H. Cohen 17 Sep. 1986 80 p
(Contract F33600-84-D-0280)
(AD-A183226; Rept-3285-4-253/1; ESD-TR-86-282) Avail: NTIS HC A05/MF A01 CSCL 09B

The purpose of the Program Office Guide to Ada is to discuss issues affecting the selection development and maintenance of systems whose software is written in the ADA language. Each volume focuses on a different set of topics and their implications for managers. This edition concentrates on: policy, run-time efficiency, customization of run-time support environments, training, Ada program design languages and conversion to non-Ada code. GRA

**N87-30089#** Illinois Univ., Urbana. Applied Computation Theory Group.
**ON FINDING THE VERTEX CONNECTIVITY OF GRAPHS**
Milind Girkar and Milind Sohoni May 1987 7 p
(Contracts N00014-84-C-0149; DE-FG02-85ER-25001; Grant NSF DCR-84-10110)
(AD-A183315; ACT-77; UILU-ENG-87-2232) Avail: NTIS HC A02/MF A01 CSCL 09B

An implementation of the fastest known algorithm to find the vertex connectivity of graphs with reduced space requirement is presented. GRA

**N87-30090#** Carnegie-Mellon Univ., Pittsburgh, Pa. Software Engineering Inst.
**PRELIMINARY REPORT ON CONDUCTING SEI-ASSISTED ASSESSMENTS OF SOFTWARE ENGINEERING CAPABILITY Final Report**
Watts S. Humphrey and David H. Kitson Jul. 1987 37 p
(Contract F19628-85-C-0003)
(AD-A183429; CMU/SEI-87-TR-16; ESD-TR-87-117) Avail: NTIS HC A03/MF A01 CSCL 12E

Characterizing the state of software engineering practice within an organization is a necessary prerequisite to orderly, meaningful, and sustainable improvement of the organization's ability to produce or support cost-effective, high quality software products. The Software Engineering Institute (SEI) is developing a methodology for conducting SEI-assisted assessments of software engineering capability. The assessment methodology has five phases: (1) selecting the candidate organization, (2) preparing for the assessment, (3) conducting the assessment, (4) communicating final assessment findings and action recommendations, and (5) post-assessment followup activities. This report describes the methodology in detail. Author (GRA)

**N87-30091#** Science Applications International Corp., Arlington, Va.
**PROCEEDINGS OF A WORKSHOP ON KNOWLEDGE-BASED SYSTEMS Annual Report, Apr. 1986 - Apr. 1987**
Lee S. Baumann Apr. 1987 201 p
(Contract N00014-86-C-0700; ARPA Order 5605)
(AD-A183430; SAIC-87/1069) Avail: NTIS HC A10/MF A01 CSCL 12E

The report of a workshop on Knowledge-based Systems contains the following: Semantically Sound Inheritance for a Formally Defined Frame Language with Defaults; Module-Oriented Programming in ABE: Modules and Abstract Datatypes; Annual Report of the Experimental Knowledge Systems Laboratory; On Making Expert Systems More Like Experts; The Loom Knowledge Representation Language; A Framework for Situation Assessment: Using Best-Explanation Reasoning to Infer Plans from Behavior; Concurrency in Abductive Reasoning; an Experiment in Knowledge-Based Signal Understanding Using Parallel Architectures; An Instrumented Architectural Simulation System; Considerations for Multiprocessor Topologies; RUM: A Layered Architecture for Reasoning with Uncertainty; Progress in Reasoning with Incomplete and Uncertain Information Part I: Reasoning with Uncertainty; Part II: Analogical Reasoning; Part III: Reasoning with Incomplete Information; An Algebraic Foundation for Truth Maintenance; Logics of Justified Belief; Using T-norm Based Uncertainty Calculi in a Naval Situation Assessment Application; A role for Assumption Based and Nonmonotonic; Justifications in Automating Strategic Threat Analysis, and a Mathematical Theory for Diagnosis Based on the MONAD Concept. GRA

**N87-30092#** Stanford Univ., Calif. Systems Optimization Lab.
**COMPARISONS OF COMPOSITE SIMPLEX ALGORITHMS**
Irvin J. Lustig Jun. 1987 71 p
(Contracts N00014-85-K-0343; DE-FG03-87ER-25028; Grants NSF DMS-84-20623; NSF ECS-83-12142; NSF SES-85-18662)
(AD-A183437; SOL-87-8) Avail: NTIS HC A04/MF A01 CSCL 09B

For almost forty years, the simplex method has been the method of choice for solving linear programs. The method consists of first finding a feasible solution to the problem (Phase 1), followed by finding the optimum (Phase 2). Many algorithms have been proposed which try to combine the processes embedded in the two-phase process. This study will compare the merits of some of these composite algorithms. Theoretical and computational aspects of the Weighted Objective, Self-Dual Parametric, and Markowitz Criteria algorithms are presented. Different variants of the Self-Dual methods are discussed. A large amount of computational experience for each algorithm is presented. These results are used to compare the algorithms in various ways. The implementations of each algorithm are also discussed. One theme that is present throughout all of the computational experience is that there is no one algorithm which is the best algorithm for all problems. GRA

**N87-30093#** Ballistic Research Labs., Aberdeen Proving Ground, Md.
**RECONSTRUCTION OF TOMOGRAPHIC IMAGES FROM SPARSE DATA SETS BY A NEW FINITE ELEMENT MAXIMUM ENTROPY APPROACH Technical Report, 1984 - 1986**
R. T. Smith, Csaba K. Zoltani, and G. J. Klem 7 Apr. 1987 42 p
(AD-A183639; BRL-TR-2797) Avail: NTIS HC A03/MF A01 CSCL 09B

A new algorithm for the reconstruction of tomographic images from parse data sets is presented. A finite element technique was devised to solve the constrained optimization problem which resulted from the analysis using the maximum entropy formalism.

The improvement in reconstruction image quality over conventional techniques is illustrated by several examples. GRA

**N87-30094#** Massachusetts Inst. of Tech., Cambridge.
**PARALLEL ALGORITHMS FOR COMPUTER VISION Contract Report, 31 Aug. 1985 - 31 Aug. 1986**
Tomaso Poggio and James Little Jan. 1987 35 p
(Contract DACA76-85-C-0010)
(AD-A183755; ETL-0456) Avail: NTIS HC A03/MF A01 CSCL 17G

The general goals of this research effort are to explore the potential applications and performance of fine grained computer architectures for vision. The body of this report gives a brief overview of the results of the research during the first twelve months. A taxonomy of parallel vision algorithms has been refined. Parallel versions of several Class 1 algorithms (for early vision, directly derived from regularization methods) have been designed. This preparatory work allowed the implementation of several of these algorithms on the Connection Machine within a few days when it became available to the researchers. Class 2 and 3 algorithms have also been designed, while at the same time studying some of the associated basic problems in recognition and representation. Author (GRA)

**N87-30095#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**BOOLEAN CLASSES**
David McAllester and Ramin Zabih Sep. 1986 16 p
(Contract N00014-85-K-0124)
(AD-A183856; AI-M-911) Avail: NTIS HC A02/MF A01 CSCL 09B

Object-oriented programming languages all involve the notions of class and object. The authors extend the notion of class so that any Boolean combination of classes is also a class. Boolean classes allow greater precision and conciseness in naming the class of objects governed by a particular method. A class can be viewed as a predicate which is either true or false of any given object. Unlike predicates, however, classes have an inheritance hierarchy which is known at compile time. Boolean classes extend the notion of class, making classes more like predicates, while preserving the compile time computable inheritance hierarchy. Author (GRA)

**N87-30096*#** Research Triangle Inst., Research Triangle Park, N.C. Center for Digital Systems Research.
**DEVELOPMENT OF N-VERSION SOFTWARE SAMPLES FOR AN EXPERIMENT IN SOFTWARE FAULT TOLERANCE Final Report**
L. Lauterbach Sep. 1987 179 p
(Contract NAS1-17964)
(NASA-CR-178363; NAS 1.26:178363; Rept-412U-2094-21; Rept-412U-3181-04) Avail: NTIS HC A09/MF A01 CSCL 09B

The report documents the task planning and software development phases of an effort to obtain twenty versions of code independently designed and developed from a common specification. These versions were created for use in future experiments in software fault tolerance, in continuation of the experimental series underway at the Systems Validation Methods Branch (SVMB) at NASA Langley Research Center. The 20 versions were developed under controlled conditions at four U.S. universities, by 20 teams of two researchers each. The versions process raw data from a modified Redundant Strapped Down Inertial Measurement Unit (RSDIMU). The specifications, and over 200 questions submitted by the developers concerning the specifications, are included as appendices to this report. Design documents, and design and code walkthrough reports for each version, were also obtained in this task for use in future studies. Author

**N87-30097*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**UNAERO: A PACKAGE OF FORTRAN SUBROUTINES FOR APPROXIMATING UNSTEADY AERODYNAMICS IN THE TIME DOMAIN**
H. J. Dunn Oct. 1985 53 p
(NASA-TM-86392; L-15862; NAS 1.15:86392) Avail: NTIS HC A04/MF A01 CSCL 09B

This report serves as an instruction and maintenance manual for a collection of CDC CYBER FORTRAN IV subroutines for approximating the unsteady aerodynamic forces in the time domain. The result is a set of constant-coefficient first-order differential equations that approximate the dynamics of the vehicle. Provisions are included for adjusting the number of modes used for calculating the approximations so that an accurate approximation is generated. The number of data points at different values of reduced frequency can also be varied to adjust the accuracy of the approximation over the reduced-frequency range. The denominator coefficients of the approximation may be calculated by means of a gradient method or a least-squares approximation technique. Both the approximation methods use weights on the residual error. A new set of system equations, at a different dynamic pressure, can be generated without the approximations being recalculated. Author

**N87-30098*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**LANGLEY VEDIT FOR NOS/VE USAGE MANUAL**
Margaret A. Heaney Sep. 1987 40 p
(NASA-TM-100499; NAS 1.15:100499) Avail: NTIS HC A03/MF A01 CSCL 09B

The use of the VEDIT editor on the CDC Network Operating System/Virtual Environment (NOS/VE) is discussed. The VEDIT, a utility, allows a user to edit files line by line (line mode). How to access and the use of VEDIT are explained. The parameters and the format of the individual commands are defined. Examples are included. Author

**N87-29521#** British Aerospace Aircraft Group, Preston (England). Advanced Systems Dept.
**A GRAPHICAL AID TO IKBS PROGRAM DEVELOPMENT**
P. J. Kearney and B. Hunt *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 18 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

## 62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

**N87-30099*#** SRI International Corp., Menlo Park, Calif. Computer Science Lab.
**DESIGN VERIFICATION OF SIFT Final Report**
Louise Moser, Michael Melliar-Smith, and Richard Schwartz Washington NASA Sep. 1987 84 p
(Contract NAS1-15528)
(NASA-CR-4097; NAS 1.26:4097) Avail: NTIS HC A05/MF A01 CSCL 09B

A SIFT reliable aircraft control computer system, designed to meet the ultrahigh reliability required for safety critical flight control applications by use of processor replications and voting, was constructed for SRI, and delivered to NASA Langley for evaluation in the AIRLAB. To increase confidence in the reliability projections for SIFT, produced by a Markov reliability model, SRI constructed a formal specification, defining the meaning of reliability in the context of flight control. A further series of specifications defined, in increasing detail, the design of SIFT down to pre- and post-conditions on Pascal code procedures. Mechanically checked mathematical proofs were constructed to demonstrate that the more detailed design specifications for SIFT do indeed imply the formal reliability requirement. An additional specification defined

some of the assumptions made about SIFT by the Markov model, and further proofs were constructed to show that these assumptions, as expressed by that specification, did indeed follow from the more detailed design specifications for SIFT. This report provides an outline of the methodology used for this hierarchical specification and proof, and describes the various specifications and proofs performed. Author

# 63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

**N87-30100#** Oak Ridge National Lab., Tenn.
**HIGH-PERFORMANCE NEURAL NETWORKS**
W. B. Dress Jun. 1987 4 p Presented at the Rochester FORTH Conference, Rochester, N.Y., 9 Jun. 1987
(Contract DE-AC05-84OR-21400)
(DE87-010591; CONF-8706115-2) Avail: NTIS HC A02/MF A01

The new Forth hardware architectures offer an intermediate solution to high-performance neural networks while the theory and programming details of neural networks for synthetic intelligence are developed. This approach has been used successfully to determine the parameters and run the resulting network for a synthetic insect consisting of a 200-node brain with 1760 interconnections. Both the insect's environment and its sensor input have thus far been simulated. However, the frequency-coded nature of the Browning network allows easy replacement of the simulated sensors by real-world counterparts. DOE

**N87-30101#** Oak Ridge National Lab., Tenn.
**FREQUENCY-CODED ARTIFICIAL NEURAL NETWORKS: AN APPROACH TO SELF-ORGANIZING SYSTEMS**
W. B. Dress 1987 9 p Presented at the 1st IEEE International Conference on Neural Networks, San Diego, Calif., 21 Jun. 1987
(Contract DE-AC05-84OR-21400)
(DE87-011122; CONF-8706130-2) Avail: NTIS HC A02/MF A01

A frequency-based model of an artificial neural network is being explored for active learning in a simulated environment and for its response to multiple modalities of input data. Physical sensors couple naturally to such a network, providing an easy migration path from simulation to application. The combination of an artificial neural network processing frequency-coded sensor information and implemented on advanced computer architectures is seen as an answer to the problems arising in robotics and the fusion of large quantities of multisensory data. DOE

**N87-30102*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**SMALL-SCALE ROTOR TEST RIG CAPABILITIES FOR TESTING VIBRATION ALLEVIATION ALGORITHMS**
Stephen A. Jacklin and Jane Anne Leyland Aug. 1987 387 p
(NASA-TM-100002; A-87271; NAS 1.15:100002) Avail: NTIS HC A17/MF A01 CSCL 09B

A test was conducted to assess the capabilities of a small scale rotor test rig for implementing higher harmonic control and stability augmentation algorithms. The test rig uses three high speed actuators to excite the swashplate over a range of frequencies. The actuator position signals were monitored to measure the response amplitudes at several frequencies. The ratio of response amplitude to excitation amplitude was plotted as a function of frequency. In addition to actuator performance, acceleration from six accelerometers placed on the test rig was monitored to determine whether a linear relationship exists between the harmonics of N/Rev control input and the least square error (LSE) identification technique was used to identify local and global transfer matrices for two rotor speeds at two batch sizes each. It was determined that the multicyclic control computer system interfaced very well with the rotor system and kept track of the input accelerometer signals and their phase angles. However, the current high speed actuators were found to be incapable of providing sufficient control authority at the higher excitation frequencies. Author

**N87-30103#** Cranfield Inst. of Tech., Bedford (England). Aerodynamics Div.
**A FINITE ELEMENT EXPERT SYSTEM: AN INITIAL STUDY AND PROTOTYPE PROGRAM Final Scientific Report, 1 Sep. 1985 - 31 Aug. 1986**
A. J. Morris Nov. 1986 47 p
(Grant AF-AFOSR-0306-85)
(AD-A183371; EOARD-TR-87-07) Avail: NTIS HC A03/MF A01 CSCL 09B

The report represents an initial study into the possibility of using Expert System concepts to aid users of finite element analysis systems. By concentrating on limited aspects of the problem a Lisp based prototype consult program has been constructed. This clearly demonstrates the advantages of adopting an Object Oriented approach in this area. The report suggest how this initial work may be further exploited to create a full scale expert system. GRA

**N87-30104#** Yale Univ., New Haven, Conn. Dept. of Computer Science.
**TEN PROBLEMS IN ARTIFICIAL INTELLIGENCE**
Roger C. Schank and Christopher C. Owens Jan. 1987 36 p
(Contract N00014-85-K-0108; Grant AF-AFOSR-0343-85)
(AD-A183552; YALEU/CSD/RR-514) Avail: NTIS HC A03/MF A01 CSCL 09B

Researchers in Artificial Intelligence have had a difficult time defining the field's goals and assessing its progress. Some have focused on the task of modelling the human brain, others have focused on developing smart machines independent of the constraints of psychological or neurological realism. Over the years the notion of what is an AI task has changed, as problems once thought to be easy have turned out to be hard, and vice versa. This paper discusses some problems that are currently of interest to the field, and places them in the context of a more enduring question: What is intelligence? It attempts to enumerate a few essential aspects of intelligence that every human, animal or intelligent machine must, to some degree, exhibit. GRA

**N87-30105#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**FUNCTIONAL ABSTRACTION FROM STRUCTURE IN VLSI SIMULATION MODELS**
Richard H. Lathrop, Robert J. Hall, and Robert S. Kirk May 1987 24 p
(Contract N00014-85-K-0124)
(AD-A183647; AI-M-903) Avail: NTIS HC A02/MF A01 CSCL 09B

High-level functional (or behavioral) simulation models are difficult, time-consuming, and expensive to develop. We report on a method for automatically generating the program code for a high-level functional simulation model. The high-level model is produced directly from the program code for the circuit components' functional models and a netlist description of their connectivity. A prototype has been implemented in LISP for the SIMMER functional simulator. GRA

**N87-30106** Carnegie-Mellon Univ., Pittsburgh, Pa.
**KINEMATIC MODELING, IDENTIFICATION AND CONTROL OF ROBOTIC MANIPULATORS Ph.D. Thesis**
Henry Wallentin Stone 1986 180 p
Avail: Univ. Microfilms Order No. DA8713903

The objective is to advance the state-of-the-art in the kinematic modeling, identification, and control of robotic manipulators with rigid links in an effort to improve robot kinematic performance. Existing robot kinematic models are not directly applicable to kinematic parameter identification. A kinematic model is introduced, called the S-model, which is applicable to kinematic parameter

identification, and used as the foundation for the development of a general technique for identifying the kinematic parameters of any robot with rigid links. The objective of the S-model identification algorithm is to estimate the S-model kinematic parameters from a set of mechanical features which are inherent to the manipulator. The initial step of the algorithm involves the explicit identification of the featured parameters. The identified features are then used to establish the position and orientations of Cartesian coordinate frames fixed relative to each link of the manipulator in accordance with the definition of the S-model. The parameters of the S-model are then computed from the estimated link coordinate frame locations. Finally, the Denavit-Hartenberg parameters for the manipulator are extracted from the identified S-model parameters. A complete prototype arm signature identification system was implemented and applied to identify the signatures and control the end effector of seven Unimation/Westinghouse Puma 560 robots. Evaluation of the experimental results has demonstrated consistent and significant improvements in the kinematic performance of all the robots tested. Dissert. Abstr.

# 64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

**N87-30107*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**A SPLINE-BASED PARAMETER AND STATE ESTIMATION TECHNIQUE FOR STATIC MODELS OF ELASTIC SURFACES**
H. T. Banks, P. L. Daniel (Southern Methodist Univ., Dallas, Tex.), and E. S. Armstrong 28 Jun. 1983 62 p
(Contracts NAS1-15810; NAS1-16394; Grants NAG1-258; NSF MCS-82-05355; AF-AFOSR-0198-81; NSF MCS-82-00883)
(NASA-CR-180449; ICASE-83-25; NAS 1.26:180449) Avail: NTIS HC A04/MF A01 CSCL 12A

Parameter and state estimation techniques for an elliptic system arising in a developmental model for the antenna surface in the Maypole Hoop/Column antenna are discussed. A computational algorithm based on spline approximations for the state and elastic parameters is given and numerical results obtained using this algorithm are summarized. Author

**N87-30108#** Brown Univ., Providence, R. I. Lefschetz Center for Dynamical Systems.
**A NUMERICAL ALGORITHM FOR OPTIMAL FEEDBACK GAINS IN HIGH DIMENSIONAL LQR (LINEAR QUADRATIC REGULATOR) PROBLEMS Report, for 15 Nov. 1985 - 27 Oct. 1986**
H. T. Banks and K. Ito Oct. 1986 35 p
(Grants AF-AFOSR-0398-84; AF-AFOSR-0303-85)
(AD-A182671; LCDS/CCS-86-47; AFOSR-87-0792TR) Avail: NTIS HC A03/MF A01 CSCL 12A

A hybrid method for computing the feed back gains in linear quadratic regulator (LQR) problems is presented. The method, which combines use of a Chandrasekhar type system with an iteration of the Newton-Kleinman form with variable acceleration parameter Smith schemes, is formulated so as to efficiently compute directly the feedback gains rather than solutions of an associated Riccati equation. The hybrid method is particularly appropriate when used with large dimensional systems such as those arising in approximating infinite dimensional (distributed parameter) control systems (e.g., those governed by delay-differential and partial differential equations). Computational advantages of our proposed algorithm over the standard eigenvector (Potter, Laub-Schur) based techniques are discussed and numerical evidence of the efficacy of our ideas presented. Author (GRA)

**N87-30109#** Australian Atomic Energy Commission, Lucas Heights.
**AN IMPLICIT ITERATIVE SCHEME FOR SOLVING LARGE SYSTEMS OF LINEAR EQUATIONS**
J. M. Barry and J. P. Pollard Dec. 1986 22 p
(DE87-702417; AAEC/E-634) Avail: NTIS (US Sales Only) HC A02/MF A01

An implicit iterative scheme for the solution of large systems of linear equations arising from neutron diffusion studies is presented. The method is applied to three-dimensional reactor studies and its performance is compared with alternative iterative approaches. DOE

**N87-30110#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.
**PRESERVATION OF NATURAL CIRCULATION SIMILARITY CRITERIA IN MATHEMATICAL MODELS**
T. K. Larson and R. A. Dimenna 1987 43 p Presented at the 24th National Heat Transfer Conference and Exhibition, Pittsburgh, Pa., 9 Aug. 1987
(Contract DE-AC07-76ID-01570)
(DE87-009720; EGG-M-34386; CONF-870816-17) Avail: NTIS HC A03/MF A01

This paper discusses preservation of similitude criteria in current mathematical models used for transient analysis of thermal-hydraulic systems. Input models for the RELAP5 computer code were developed for two simple hypothetical natural circulation systems consisting of a closed loop containing energy generation, energy removal, and flow resistance. The two models differed significantly in geometric scale size. A reference model had components and operating conditions in a range similar to those found in typical nuclear steam supply systems; a scaled model, geometrically much smaller than the reference model, had components that were sized from the reference model using similarity criteria presented in the literature. Steady-state and transient single- and two phase natural circulation calculations were conducted using both models to determine if the model-to-model relationships in time-, pressure drop-, and velocity scales were in accordance with the relations given in the literature. Results from the calculations and analysis conducted indicate that while the code predicts the expected fundamental effects of geometric scale, there are noteworthy differences in the details of calculations. DOE

**N87-30111*#** Colorado Univ., Boulder. Center for Space Structures and Controls.
**A COMPUTATIONAL PROCEDURE FOR LARGE ROTATIONAL MOTIONS IN MULTIBODY DYNAMICS Semiannual Status Report, 13 Apr. - 13 Oct. 1987**
K. C. Park and J. C. Chiou Aug. 1987 28 p
(Grant NAG1-756)
(NASA-CR-181222; NAS 1.26:181222; CU-CSSC-87-08) Avail: NTIS HC A03/MF A01 CSCL 12A

A computational procedure suitable for the solution of equations of motion for multibody systems is presented. The present procedure adopts a differential partitioning of the translational motions and the rotational motions. The translational equations of motion are then treated by either a conventional explicit or an implicit direct integration method. A principle feature of this procedure is a nonlinearly implicit algorithm for updating rotations via the Euler four-parameter representation. This procedure is applied to the rolling of a sphere through a specific trajectory, which shows that it yields robust solutions. Author

**N87-30112*#** Drexel Univ., Philadelphia, Pa.
**CONTROLLER DESIGN VIA STRUCTURAL REDUCED MODELING BY FETM Final Report**
Ajmal Yousuff 1 Oct. 1987 45 p
(Grant NAG1-622)
(NASA-CR-180416; NAS 1.26:180416) Avail: NTIS HC A03/MF A01 CSCL 12A

The Finite Element-Transfer Matrix (FETM) method has been developed to reduce the computations involved in analysis of structures. This widely accepted method, however, has certain limitations, and does not address the issues of control design. To overcome these, a modification of the FETM method has been developed. The new method easily produces reduced models

tailored toward subsequent control design. Other features of this method are its ability to: (1) extract open loop frequencies and mode shapes with less computations, (2) overcome limitations of the original FETM method, and (3) simplify the design procedures for output feedback, constrained compensation, and decentralized control. This report presents the development of the new method, generation of reduced models by this method, their properties, and the role of these reduced models in control design. Examples are included to illustrate the methodology. Author

**N87-30113#** Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.

**THE EXPLICITLY-INTERFACED METHOD AND THE RESPONSE MATRIX METHOD: TWO METHODS FOR THE SOLUTION OF THE TRANSPORT EQUATION**

J. A. Rathkopf, L. J. Lorence, and W. R. Martin 1987 15 p Presented at the American Nuclear Society International Meeting on Advances in Reactor Physics, Mathematics and Computation, Paris, France, 27 Apr. 1987 Prepared in cooperation with Sandia National Labs., Albuquerque, N. Mex. and Michigan Univ., Ann Arbor

(Contract DE-AC04-76DP-00789)

(DE87-001730; SAND-86-2364C; CONF-870424-2) Avail: NTIS HC A02/MF A01

The phase space finite element method when applied to the first order transport equation results in a matrix equation that can only be solved directly. While the direct solution procedure is competitive with more established transport methods for one-dimensional geometries, it is much too slow in two or more dimensions. This summary presents two alternative implementations of the finite element method. Both reduce the size of the matrix to be solved by dividing the spatial domain into smaller regions, and both realize increased efficiency in multi-dimensional applications. Following brief derivations of the methods, computational results for both one-dimensional and two-dimensional applications will be presented and compared for the two distinct approaches. DOE

**N87-30114*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**ON IMPLICIT RUNGE-KUTTA METHODS FOR PARALLEL COMPUTATIONS**

Stephen L. Keeling Sep. 1987 24 p

(Contract NAS1-18107)

(NASA-CR-178366; ICASE-87-58; NAS 1.26:178366) Avail: NTIS HC A02/MF A01 CSCL 12A

Implicit Runge-Kutta methods which are well-suited for parallel computations are characterized. It is claimed that such methods are first of all, those for which the associated rational approximation to the exponential has distinct poles, and these are called multiply explicit (MIRK) methods. Also, because of the so-called order reduction phenomenon, there is reason to require that these poles be real. Then, it is proved that a necessary condition for a ç-stage, real MIRK to be A sub 0-stable with maximal order q + 1 is that q = 1, 2, 3, or 5. Nevertheless, it is shown that for every positive integer q, there exists a q-stage, real MIRK which is l-stable with order q. Finally, some useful examples of algebraically stable MIRKs are given. Author

**N87-30115** Deutsche Geodaetische Kommission, Munich (West Germany).

**A NEW WAY FOR THE CALCULATION OF THREE-DIMENSIONAL HELMERT TRANSFORMATIONS [EIN NEUER WEG ZUR BERECHNUNG DREIDIMENSIONALER HELMERTTRANSFORMATIONEN]**

Gerhard Heindl 1986 37 p In GERMAN

(Ser-A-103; ISBN-3-7696-8185-I; ISSN-0065-5309; ETN-87-90353) Copyright Avail: Issuing Activity

Three-dimensional Helmert transformations in applied geodesy were calculated. It is shown that the nonlinear adjustment problem (P) and its variants have solutions, and that of reduction of the problems to the determination of extrema of a function is possible. In order to obtain a complete solution of P and its variants, the extrema of f were characterized by solutions of an eigenvalue problem. Using this characterization, the uniqueness questions concerning the existence of Helmert transformations were clarified and the possibility for an exact, numerical solution of P was opened. A priori estimates and error estimates are discussed. ESA

**N87-30116*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**POLYNOMIAL APPROXIMATION OF FUNCTIONS OF MATRICES AND ITS APPLICATION TO THE SOLUTION OF A GENERAL SYSTEM OF LINEAR EQUATIONS Final Report**

Hillel Tal-Ezer Sep. 1987 47 p Submitted for publication

(Contract NAS1-18107)

(NASA-CR-178376; ICASE-87-63; NAS 1.26:178376) Avail: NTIS HC A03/MF A01 CSCL 12A

During the process of solving a mathematical model numerically, there is often a need to operate on a vector v by an operator which can be expressed as f(A) while A is NxN matrix (ex: exp(A), sin(A), A sup -1). Except for very simple matrices, it is impractical to construct the matrix f(A) explicitly. Usually an approximation to it is used. In the present research, an algorithm is developed which uses a polynomial approximation to f(A). It is reduced to a problem of approximating f(z) by a polynomial in z while z belongs to the domain D in the complex plane which includes all the eigenvalues of A. This problem of approximation is approached by interpolating the function f(z) in a certain set of points which is known to have some maximal properties. The approximation thus achieved is almost best. Implementing the algorithm to some practical problem is described. Since a solution to a linear system Ax = b is x= A sup -1 b, an iterative solution to it can be regarded as a polynomial approximation to f(A) = A sup -1. Implementing the algorithm in this case is also described. Author

**N87-30117*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**GALERKIN/RUNGE-KUTTA DISCRETIZATIONS FOR PARABOLIC EQUATIONS WITH TIME DEPENDENT COEFFICIENTS Final Report**

Stephen L. Keeling Sep. 1987 41 p Submitted for publication

(Contract NAS1-18107)

(NASA-CR-178372; ICASE-87-61; NAS 1.26:178372) Avail: NTIS HC A03/MF A01 CSCL 12A

A new class of fully discrete Galerkin/Runge-Kutta methods is constructed and analyzed for linear parabolic initial boundary value problems with time dependent coefficients. Unlike any classical counterpart, this class offers arbitrarily high order convergence while significantly avoiding what has been called order reduction. In support of this claim, error estimates are proved, and computational results are presented. Additionally, since the time stepping equations involve coefficient matrices changing at each time step, a preconditioned iterative technique is used to solve the linear systems only approximately. Nevertheless, the resulting algorithm is shown to preserve the original convergence rate while using only the order of work required by the base scheme applied to a linear parabolic problem with time independent coefficients. Furthermore, it is noted that special Runge-Kutta methods allow computations to be performed in parallel so that the final execution time can be reduced to that of a low order method. Author

**N87-30118#** Naval Research Lab., Washington, D.C.

**LAGRANGIAN MULTIPLIERS AND SUPERFLUOUS VARIABLES Final Report**

Steve Bravy 12 Jun. 1987 17 p

(AD-A183067; NRL-MR-6001) Avail: NTIS HC A02/MF A01 CSCL 12A

This paper develops new forms for the Lagrangian Multipliers used in studies of constrained systems, as well as variants of the Euler Lagrange equations. These formulas facilitate the computation of the multipliers and solution of the Euler Lagrange equations. In addition, the link between virtual displacement and the multipliers Euler Lagrange is elucidated. GRA

**N87-30119#** Maryland Univ., College Park. Inst. for Physical Science and Technology.
**COMMENTS ON THE DEVELOPMENT OF COMPUTATIONAL MATHEMATICS IN CZECHOSLOVAKIA AND IN THE USSR Final Report**
I. Babuska Mar. 1987 11 p
(Contract N00014-85-K-0169)
(AD-A183115; BN-1060) Avail: NTIS HC A02/MF A01 CSCL 12A

This document presents an invited lecture at the ACM Conference on the History of Scientific and Numeric Computations, May 13-15, 1987, Princeton, New Jersey. It present some basic subjective observations about the history of numerical methods in Czechoslovakia and USSR up to the mid 60s. GRA

**N87-30120#** Maryland Univ., College Park. Inst. for Physical Science and Technology.
**THE p-VERSION OF THE FINITE ELEMENT METHOD FOR CONSTRAINT BOUNDARY CONDITIONS Final Report**
I. Babuska and Manil Suri Apr. 1987 31 p
(Contract N00014-85-K-0169; Grant AF-AFOSR-0322-85)
(AD-A183231; BN-1064) Avail: NTIS HC A03/MF A01 CSCL 12A

This paper addresses the implementation of general constraint boundary conditions for a system of equations by the p-version of the finite element method. By constraint boundary conditions the authors mean conditions where some relation between the components is prescribed at the boundary. Optimal error bounds are proven. GRA

**N87-30121#** Naval Postgraduate School, Monterey, Calif.
**A COMPARATIVE ANALYSIS OF A GENERALIZED LANCHESTER EQUATION MODEL AND A STOCHASTIC COMPUTER SIMULATION MODEL M.S. Thesis**
Terry A. West Mar. 1987 145 p
(AD-A183358) Avail: NTIS HC A07/MF A01 CSCL 12A

This thesis involved a numerical experiment to compare a deterministic Generalized Lanchester Equation model, referred to as the M/W model, and a stochastic computer simulation model, referred to as the C/S model. A discussion of the historical background of Lanchester's equations precedes the presentation of the two models and the experimental design. The results are presented graphically and show that the M/W force level trajectory is a good approximation for the C/S force level trajectory. It was also shown that the two model's trajectories behaved similarly. These results indicate that deterministic attrition models may often be good approximations for the mean of stochastic combat attrition models. Command and control applications of a model like the M/W model are presented and a list of suggested follow-on research is provided to stimulate further work in this area. GRA

**N87-30122#** Maryland Univ., College Park. Inst. for Physical Science and Technology.
**THE TREATMENT OF NONHOMOGENEOUS DIRICHLET BOUNDARY CONDITIONS BY THE p-VERSION OF THE FINITE ELEMENT METHOD Final Report**
I. Babuska and Manil Suri Apr. 1987 45 p
(Contract N00014-85-K-0169; Grant AF-AFOSR-0322-85)
(AD-A183363; BN-1063) Avail: NTIS HC A03/MF A01 CSCL 12A

A recent addition to the field of finite element analysis has been the development of the p and h-p versions of the finite element method. For two-dimensional problems the p and h-p versions have been implemented in the commercial system PROBE by Noetic Tech., St. Louis with a first release in 1985 and the second in 1986. The three-dimensional commercial finite element code FIESTA having some p-version capabilities had been developed at ISMES (Institute Sperimentali Modelli e Structture) in Bergamo, Italy, and has been available since 1980 in the United States. An implementation of the three-dimensional p and h-p versions for the Cray computers is presently being done at the Aeronautical Research Institute of Sweden and by Noetic Tech. The paper addresses the problem of the implementation of nonhomogeneous essential Dirichlet type boundary conditions in the p-version of the finite element method. GRA

**N87-30123#** Washington Univ., Seattle. Dept. of Statistics.
**INFERENCE FOR THE BINOMIAL N PARAMETER: A BAYES EMPIRICAL BAYES APPROACH, REVISION**
Adrian E. Raftery Jul. 1987 18 p
(Contract N00014-84-C-0169)
(AD-A183432; TR-85) Avail: NTIS HC A02/MF A01 CSCL 12C

The problem of inference about the binomial N parameter is considered. Applications arise in situations where an unknown population size is to be estimated. Previous work has focused on point estimation, but many applications require interval estimation, prediction, and decision-making. A Bayes empirical Bayes approach is presented. This provides a simple and flexible way of specifying prior information, and also allows a convenient representation of vague prior knowledge. It yields solutions to the problems interval estimation, prediction, and decision-making, as well as that of point estimation. The Bayes estimator compares favorably with the best, previously proposed, point estimators in the literature. The Bayesian estimation interval which corresponds to a vague prior distribution also performs satisfactorily when used as a frequentist confidence interval. GRA

**N87-30124#** Center for Naval Analyses, Alexandria, Va. Air Warfare Research Dept.
**CONTINUOUS DEPENDENCE ON MODELING IN THE CAUCHY PROBLEM FOR NONLINEAR ELLIPTIC EQUATIONS**
Allan Bennett Apr. 1987 55 p
(AD-A183582; CNA-PP-455) Avail: NTIS HC A04/MF A01 CSCL 12A

The Cauchy problem for various types of secondary order nonlinear elliptic equations is considered. A substitution v=epsilon u in the equation leads to a perturbed equation whose solution is compared to an appropriate solution of an unperturbed second order linear elliptic equation obtained by formally setting epsilon=O. In each case a logarithmic convexity argument is used to show that appropriately constrained solutions of the original equation (assumed to exist) are shown to differ from a solution of the associated linear equation in the manner depending continuously on the parameter epsilon. GRA

**N87-30125#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**EXTRACTING QUALITATIVE DYNAMICS FROM NUMERICAL EXPERIMENTS**
Kenneth M. Yip Mar. 1987 21 p
(Contract N00014-85-K-0124)
(AD-A183633; AI-M-950) Avail: NTIS HC A02/MF A01 CSCL 12D

A central problem in Qualitative Physics is the qualitative prediction of long-time behavior of physical systems. The machinery developed for qualitative reasoning (qualitative state vector, quantity space, and limit analysis) are largely applicable to systems which are piecewise well approximated by low-order linear systems or by first-order nonlinear differential equations. Typical nonlinear systems (those commonly encountered in Physics) exhibit a far richer spectrum of dynamical behavior. Look at the simplest nontrivial form of conservative systems, the area-preserving maps, to provide a new source of examples for investigation into the fundamental issues of descriptive language, style of reasoning, and representation techniques. To automate the experimenting process, two key problems, i.e., automatic experiment control, and result interpretation, have to be solved. Knowledge of qualitative dynamics and bifurcations provides a strong constraint on the type of dynamical behavior possible. This can be exploited to solve the problems. An approach to the control problem is based on this idea. The interpretation problem is solved by using techniques from computational geometry and computer vision. GRA

**N87-30126#** Maryland Univ., College Park. Inst. for Physical Science and Technology.
**THE THEORY AND PRACTICE OF THE h-p VERSION OF FINITE ELEMENT METHOD Final Report**
Ben Q. Guo and Ivo Babuska Apr. 1987 10 p
(Contract N00014-85-K-0169; Grant NSF DMS-85-16191)
(AD-A183656; BN-1062) Avail: NTIS HC A02/MF A01 CSCL 12A

There are three versions of finite element methods. The classical h-version achieves the accuracy by refining the mesh while using low degrees P of elements, p=1,2 usually. The p-version keeps the mesh fixed and the accuracy is achieved by increasing the degree p. The h-p version properly combines both approaches. The h-p version is the new development of finite element method. It was first addressed by Babuska and Dorr. The further analysis and computation for two dimensional problems were made by Guo, Babuska where the exponential rate of convergence was proved. The one dimensional analysis was given by Guo, Babuska. The improvement of the results for curvilinear boundary and curvilinear elements was made by Babuska, Guo. The problem with non-homogeneous Dirichlet data was studied by Babuska, Guo. The h-p version with elements for the problem of 2m order was discussed by Guo. The feedback and adaptive approach was developed by Guo, Babuska and Babuska, Rank. Here, some theoretical advances are addressed. GRA

**N87-30127#** Army Mathematics Steering Committee.
**PROCEEDINGS OF THE 32ND CONFERENCE ON THE DESIGN OF EXPERIMENTS IN ARMY RESEARCH DEVELOPMENT AND TESTING Interim Technical Report**
Jun. 1987 423 p Conference held in Monterey, Calif., 29-31 Oct 1986
(AD-A183752; ARO-87-2) Avail: NTIS HC A18/MF A01 CSCL 14B

The partial contents of a report on Experiment Design in Army Research and Development presented are: Statistical analysis for intercropping experiments; Scoring casualties from field; Maximum-likelihood estimation of the parameters of a four-parameter class of probability distributions; On rotation in factor analysis of atmospheric parameters; An exact method for one-sided tolerance limits in the presence of batch-to-batch variation; Distribution of the empty cells in a generalized random allocation scheme; Application of experimental design to the evaluation of expert opinion; Analysis of incomplete block design with missing cells; Heuristic approach to post-hoc comparisons for significant interactions simplified notation; Statistical evaluation of desert individual camouflage covers by ground observers; Combinatorics of message filtering; Use of the P-value and a Q-value in rejection criteria; Incorporating fuzzy set theory into statistical hypothesis testing; Application of a fuzzy random variable to vulnerability modeling; Problems encountered in fitting a large number of short time series; Feasibility of generating predictive analysis model by using the Army's Existing Data source; Quantile statistical data analysis; Comparison of two sensitivity testing procedures with implications for sample size determination. GRA

# 65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

**N87-30128*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**INTERACTIVE APPLICATION OF QUADRATIC EXPANSION OF CHI-SQUARE STATISTIC TO NONLINEAR CURVE FITTING**
F. F. Badavi (PRC Kentron, Inc., Hampton, Va.) and Joel L. Everhart Oct. 1987 36 p
(NASA-TM-4012; L-16316; NAS 1.15:4012) Avail: NTIS HC A03/MF A01 CSCL 12A

This report contains a detailed theoretical description of an all-purpose, interactive curve-fitting routine that is based on P. R. Bevington's description of the quadratic expansion of the Chi-Square statistic. The method is implemented in the associated interactive, graphics-based computer program. Taylor's expansion of Chi-Square is first introduced, and justifications for retaining only the first term are presented. From the expansion, a set of n simultaneous linear equations is derived, then solved by matrix algebra. A brief description of the code is presented along with a limited number of changes that are required to customize the program of a particular task. To evaluate the performance of the method and the goodness of nonlinear curve fitting, two typical engineering problems are examined and the graphical and tabular output of each is discussed. A complete listing of the entire package is included as an appendix. Author

**N87-30129#** Army Engineer Waterways Experiment Station, Vicksburg, Miss. Inst. Services Div.
**NETWORKS OF MARKOVIAN QUEUES Final Technical Report**
Raphael A. Franco, Jr. May 1987 299 p
(AD-A182994; WES/TR/O-87-2) Avail: NTIS HC A13/MF A01 CSCL 12A

There is a recognized need to make the subject of queueing network theory less esoteric. The thrust of this text is to examine queueing network theory as presented in the literature, to reinforce the results by independent justifications, to reduce the ambiguity present in some explanations, and to present numerous corroborating examples where none were found. The result is that the existing literature, in the area covered, has been expanded in explanation, critiqued as to usage, and delineated as to limitations. GRA

**N87-30130#** Ford Aerospace and Communications Corp., Palo Alto, Calif. Development Lab. Div.
**PROBABILISTIC METHODS Final Report**
Austin J. Lemoine and Michael L. Wenocur 16 Apr. 1987 10 p
(Contract F49620-86-C-0022)
(AD-A183163; AFOSR-87-0935TR) Avail: NTIS HC A02/MF A01 CSCL 12A

Research was performed in several means of probabilistic methods. Primary results include representations of equilibrium sojourn time distribution in Jackson networks of queues. New practical and theoretical results in computing first passage time statistics are developed. Promising results for developing a method for inverting large sparse motives were obtained. The scientific objectives of this research program are to develop improved probabilistic and statistical methods and to demonstrate their power and relevance through application to specific problems in stochastic networks and system reliability. The seven technical papers in this document are entitled: On Failure Modeling; A Stochastic Network Process; On Shot Noise and Reliability Modeling; Brownian Motion with Quadratic Killing and Some Implications; On Sojourn Time in Jackson Networks of Queques; On First Passage Times and Differential Equations; and Algorithms for Inverting Large Space Matrices. GRA

**N87-30131*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**THE MINIMAL RESIDUAL QR-FACTORIZATION ALGORITHM FOR RELIABLY SOLVING SUBSET REGRESSION PROBLEMS**
M. H. Verhaegen Sep. 1987 15 p
(NASA-TM-100021; A-87334; NAS 1.15:100021) Avail: NTIS HC A02/MF A01 CSCL 12A

A new algorithm to solve test subset regression problems is described, called the minimal residual QR factorization algorithm (MRQR). This scheme performs a QR factorization with a new column pivoting strategy. Basically, this strategy is based on the change in the residual of the least squares problem. Furthermore, it is demonstrated that this basic scheme might be extended in a numerically efficient way to combine the advantages of existing numerical procedures, such as the singular value decomposition, with those of more classical statistical procedures, such as stepwise regression. This extension is presented as an advisory expert system that guides the user in solving the subset regression problem. The advantages of the new procedure are highlighted by a numerical example. Author

# 66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

**N87-30132*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**OPTIMIZING THE ANTENNA SYSTEM OF A MICROWAVE SPACE POWER STATION: IMPLICATIONS FOR THE SELECTION OF OPERATING POWER, FREQUENCY AND ANTENNA SIZE**

Robert M. Manning Sep. 1987 9 p
(NASA-TM-100184; E-3761; NAS 1.15:100184) Avail: NTIS HC A02/MF A01 CSCL 12B

A design for a space power station that is to transmit power to the surface of a planet via high powered microwaves should commence with the optimum design of the transmitting and receiving antenna combination to be employed. Once one has assured that the desired amount of power has been transferred (which, after all, is the prupose of any power transmission system), one can, from the constraints imposed by such a design, taylor other parameters of the system such as antenna sizes and weights, power density in the planet's atmosphere (e.g., to avoid electrical breakdown), and frequency of operation. It is the purpose of this brief analysis to provide the working equations of such an optimized antenna system, and to give examples of their use. Related problems that should be analyzed in the future will then be discussed and a flow chart of the indicated order of priority presented. The analysis given here differs from previous work on this subject in that the development given will allow analytical expressions to be obtained for the relevant parameters. This is made possible by employing an approximation procedure to be given during the exposition. Author

**N87-30133*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**THE USE OF THE QR FACTORIZATION IN THE PARTIAL REALIZATION PROBLEM**

M. H. Verhaegen Sep. 1987 30 p Submitted for publication
(NASA-TM-100018; A-87316; NAS 1.15:100018) Avail: NTIS HC A03/MF A01 CSCL 12B

The use of the QR factorization of the Hankel matrix in solving the partial realization problem is analyzed. Straightforward use of the QR factorization results in a realization scheme that possesses all of the computational advantages of Rissanen's realization scheme. These latter properties are computational efficiency, recursiveness, use of limited computer memory, and the realization of a system triplet having a condensed structure. Moreover, this scheme is robust when the order of the system corresponds to the rank of the Hankel matrix. When this latter condition is violated, an approximate realization could be determined via the QR factorization. In this second scheme, the given Hankel matrix is approximated by a low-rank non-Hankel matrix. Furthermore, it is demonstrated that column pivoting might be incorporated in this second scheme. The results presented are derived for a single input/single output system, but this does not seem to be a restriction. Author

**N87-30134#** Department of Defense, Washington, D. C. Strategic Defense Initiative Organization.

**STRATEGIC DEFENSE INITIATIVE DEMONSTRATION/VALIDATION PROGRAM ENVIRONMENTAL ASSESSMENTS SUMMARY**

G. Brown Aug. 1987 155 p
(AD-A183000) Avail: NTIS HC A08/MF A01 CSCL 12B

The Strategic Defense Initiative Organization (SDIO) and its proponents (the U.S. Army and U.S. Air Force) plan to conduct Demonstration/Validation tests of the six technologies to demonstrate their respective ability to perform required tasks, and to validate the requirements to determine feasibility for a future decision on whether to proceed with full-scale development. Demonstration/Validation tests would be conducted at 14 government facilities across the United States and the Republic of the Marshall Islands, and at contractor facilities. Tests would include analyses, simulations, component/assembly tests, and flight tests. This document summarizes the findings expressed in the six Environmental Assessments for Demonstration/Validation testing of the individual technologies, and analyzes the potential cumulative environmental consequences of testing of multiple technologies at a given facility. In the event that any other technology is ready for entry into Demonstration/Validation at a later date, an Environmental Assessment will be prepared for that technology and this summary will be updated. GRA

**N87-30135#** Department of Defense, Washington, D. C. Strategic Defense Initiating Organization.

**STRATEGIC DEFENSE INITIATIVE DEMONSTRATION/VALIDATION PROGRAM ENVIRONMENTAL ASSESSMENT. BOOST SURVEILLANCE AND TRACKING SYSTEM (BSTS)**

G. Brown Aug. 1987 55 p
(AD-A183001) Avail: NTIS HC A04/MF A01 CSCL 12B

The Strategic Defense Initiative Organization (SDIO) and its proponents (U.S. Air Force) plan to conduct Demonstration/Validation tests of the BSTS technology. These tests will demonstrate the ability of the technology to perform required tasks, and will validate a future decision on whether to proceed with Full-Scale Development. Demonstration/Validation tests would be conducted at the National Test facility, Cape Canaveral Air Force Station/Eastern Test Range, and at contractor facilities. Tests would include analyses, simulations, component/assembly tests, and flight tests. This document addresses the potential environmental consequences of the Demonstration/Validation testing of the BSTS technology. Emphasis is upon the Boost Surveillance and Tracking System. GRA

**N87-30136#** Department of Defense, Washington, D. C. Strategic Defense Initiative Organization.

**STRATEGIC DEFENSE INITIATIVE DEMONSTRATION/VALIDATION PROGRAM ENVIRONMENTAL ASSESSMENT/SPACE-BASED SURVEILLANCE AND TRACKING SYSTEM (SSTS)**

G. Brown Aug. 1987 89 p
(AD-A183002) Avail: NTIS HC A05/MF A01 CSCL 12B

The Strategic Defense Initiative Organization (SDIO) and its proponents (the U.S. Army and the U.S. Air Force) plan to conduct Demonstration/Validation tests of the SSTS technology. These tests will demonstrate the ability of the technology to perform required tasks, and will validate a future decision on whether to proceed with Full-Scale Development. Tests would include analyses, simulations, component/assembly tests, and flight tests. This document addresses the potential environmental consequences of the Demonstration/Validation testing of the SSTS technology. GRA

**N87-30137#** Department of Defense, Washington, D. C. Strategic Defense Initiative Organization.

**STRATEGIC DEFENSE INITIATIVE DEMONSTRATION/VALIDATION PROGRAM ENVIRONMENTAL ASSESSMENT. GROUND-BASED SURVEILLANCE AND TRACKING SYSTEM (GSTS)**

G. Brown Aug. 1987 84 p
(AD-A183003) Avail: NTIS HC A05/MF A01 CSCL 12B

The Strategic Defense Initiative Organization (SDIO) and its proponents (the U.S. Army and the U.S. Air Force) plan to conduct Demonstration/Validation tests of the GSTS technology. These tests will demonstrate the ability of the technology to perform required tasks, and to validate production feasibility in support of a future decision on whether to proceed with Full-Scale Development. This document addresses the potential environment consequences of the Demonstration/Validation testing of the GSTS technology. Emphasis is upon the Ground-based Surveillance and Tracking System. GRA

**N87-30138#** Department of Defense, Washington, D. C. Strategic Defense Initiative Organization.
**STRATEGIC DEFENSE INITIATIVE DEMONSTRATION/VALIDATION PROGRAM ENVIRONMENTAL ASSESSMENT. SPACE-BASED INTERCEPTOR (SBI)**
G. Brown Aug. 1987 81 p
(AD-A183004) Avail: NTIS HC A05/MF A01 CSCL 12B

The Strategic Defense Initiative Organization (SDIO) and its proponents (the U.S. Army and the U.S. Air Force) plan to conduct Demonstration/Validation tests of the SBI technology. These tests will demonstrate the ability of the technology to perform the required tasks, and validate a future decision on whether to proceed with Full-Scale Development. Tests would include analyses, simulations, component/assembly tests, and flight tests. This document addresses the potential environmental consequences of the Demonstration/Validation testing of the SBI technology. Emphasis is upon the Space-Based Interceptor. GRA

**N87-30139#** Department of Defense, Washington, D. C. Strategic Defense Initiative Organization.
**STRATEGIC DEFENSE INITIATIVE DEMONSTRATION/VALIDATION PROGRAM ENVIRONMENTAL ASSESSMENT. EXOATMOSPHERIC REENTRY VEHICLE INTERCEPTION SYSTEM (ERIS)**
G. Brown Aug. 1987 109 p
(AD-A183005) Avail: NTIS HC A06/MF A01 CSCL 12B

The Strategic Defense Initiative Organization (SDIO) and its proponents (the U.S. Army and the U.S. Air Force) plan to conduct Demonstration/Validation tests of the ERIS technology. These tests will demonstrate the ability of the technology to perform the required tasks, and validate a future decision whether to proceed with Full-Scale Developer. Demonstration/Validation tests would be conducted at the Arnold Engineering Development Center, National Test Facility, Nevada Test Site, Harry Diamond Laboratories, Vandenberg Air Force Base/Western Test Range, U.S. Army Kwajalein Atoll, U.S. Naval Pacific Missile Range at Barking Sands, and contractor facilities. Tests would include analyses, simulations, component/assembly tests, and flight tests. This document addresses the potential environmental consequences of the Demonstration/Validation testing of the ERIS technology. GRA

**N87-30140#** Department of Defense, Washington, D. C. Strategic Defense Initiative Organization.
**STRATEGIC DEFENSE INITIATIVE DEMONSTRATION/VALIDATION PROGRAM ENVIRONMENTAL ASSESSMENT. BATTLE MANAGEMENT/COMMAND AND CONTROL, AND COMMUNICATIONS (BM/C3)**
G. Brown Aug. 1987 76 p
(AD-A183006) Avail: NTIS HC A05/MF A01 CSCL 12B

The Strategic Defense Initiative Organization (SDIO) and its proponents (U.S. Army and U.S. Air Force) plan to conduct Demonstration/Validation tests of the BM/C3 technology. These tests will demonstrate the ability of the technology to perform the required tasks, and will validate a future decision on whether to proceed with Full-Scale Development. Demonstration/Validation tests would be conducted at the Advanced Research Center, Electronic Systems Division, National Test Facility, Rome Air Development Center, Nevada Test Site, Harry Diamond Laboratories, and at contractor facilities. Tests would include analyses, simulations, and component/assembly tests. This document addresses the potential environmental consequences of the Demonstration/Validation testing of the BM/C3 technology. GRA

**N87-30141#** Strategic Defense Initiative Organization, Washington, D.C.
**SDIO (STRATEGIC DEFENSE INITIATIVE OFFICE) TECHNICAL INFORMATION MANAGEMENT CENTER BIBLIOGRAPHY OF UNCLASSIFIED REPORTS: JANUARY - DECEMBER 1986**
Dec. 1986 69 p
(AD-A183875) Avail: NTIS HC A04/MF A01 CSCL 15C

This bibliography lists the Strategic Defense Initiative Organization Technical Information Management Centers holdings of publications pertaining to such topics as Software Testing Measures, Digital Beamforming Arrays, Experimental Electromagnetic Launchers, Rail Guns, Artificial Intelligence, Microwave Imaging, Optical Technology, Soviet Military Power, and Soviet Laser Developments. GRA

**N87-30142#** Strategic Defense Initiative Organization, Washington, D.C.
**SDIO (STRATEGIC DEFENSE INITIATIVE OFFICE) TECHNICAL INFORMATION MANAGEMENT CENTER BIBLIOGRAPHY OF UNCLASSIFIED BOOKS: JANUARY - DECEMBER 1986**
Dec. 1986 28 p
(AD-A183876) Avail: NTIS HC A03/MF A01 CSCL 15C

This bibliography lists the Strategic Defense Initiative Organization Technical Information Management Center's holdings of publications pertaining to such topics as ballistic missile defense, arms control impact statements, beam weapons, strategic decision making, aluminum lithium alloys, laser weapons, military space policy, and radar electronic counter countermeasures. GRA

# 67 THEORETICAL MATHEMATICS

Includes topology and number theory.

**N87-30143#** Southeastern Univ. Research Association, Newport News, Va.
**RELATIVISTIC EQUATIONS**
F. Gross 1986 15 p Presented at the European Workshop on Few Body Physics, Rome, Italy, 7 Oct. 1986 Prepared in cooperation with College of William and Mary, Williamsburg, Va.
(Contract DE-AC05-84ER-40150)
(DE87-008665; DOE/ER-40150/17; CEBAF-PR-86-011; CONF-8610196-6) Avail: NTIS MF A01

Relativistic equations for two and three body scattering are discussed. Particular attention is paid to relativistic three body kinetics because of recent form factor measurements of the Helium 3 - Hydrogen 3 system recently completed at Saclay and Bates and the accompanying speculation that relativistic effects are important for understanding the three nucleon system. DOE

# 70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

**N87-30144*#** California Inst. of Tech., Pasadena.
**OPTICAL RADIATION FROM SHOCK-COMPRESSED MATERIALS Ph.D. Thesis**
Robert F. Svendsen, Jr. 17 Jul. 1987 406 p Sponsored in part by NSF
(Grant NGL-105-002-105)
(NASA-CR-180382; NAS 1.26:180382) Avail: NTIS HC A18/MF A01 CSCL 20C

Recent observations of shock-induced radiation from oxides, silicates, and metals of geophysical interest constrain the shock-compressed temperature of these materials. The relationships between the temperature inferred from the observed radiation and the temperature of the shock-compressed film or foil and/or window were investigated. Changes of the temperature field in each target component away from that of their respective shock-compressed states occur because of: shock-impedance mismatch between target components; thermal mismatch between target components; surface roughness at target interfaces; and conduction within and between target components. In particular, conduction may affect the temperature of the film/foil window interface on the time scale of the experiments, and so control the intensity and history of the dominant thermal radiation sources in the target. This type of model was used to interpret the radiation

emitted by a variety of shock-compressed materials and interfaces. Author

**N87-30145#** Joint Publications Research Service, Arlington, Va.
**USSR REPORT: PHYSICS AND MATHEMATICS**
9 Apr. 1987 57 p Transl. into ENGLISH from various Russian articles
(JPRS-UPM-87-005) Avail: NTIS HC A04/MF A01

Topics addressed include: crystals, laser glasses, semiconductors, fluid dynamics, lasers, nuclear physics, optics, spectroscopy, plasma physics, theoretical physics, and technical physics. For individual titles, see N87-30146 through N87-30148.

**N87-30146#** Joint Publications Research Service, Arlington, Va.
**MICROWAVE LIGHT MODULATORS WITH SPACED CRYSTALS Abstract Only** **c74**
K. S. Gyunashyan, V. A. Papyan, and M. K. Sagatelyan *In its* USSR Report: Physics and Mathematics 9 Apr. 1987 p 14-15 Transl. into ENGLISH from Izvestiya Akademii Nauk Armyanskoy SSR: Seriya Tekhnicheskikh Nauk (Yerevan, USSR), v. 39, no. 3, May - Jun. 1986 p 24-27 (For primary document see N87-30145 24-70)
Avail: NTIS HC A04/MF A01

A biaxial microwave light modulator was developed for optical high-precision range meters Mekometr MYe-3000 and DVSD-1200, its reference prototype version consisting of a resonator loaded with a crystal-capacitor. An analysis of the electric field distribution around the crystal mount in the resonator cavity indicates the possibility of mounting in the cavity two identical crystals spaced symmetrically with respect to the cavity center so far apart as to facilitate matching the receiver-transmitter optics with the modulator. The correct location of the crystals corresponds to the first two maxima of the Bessel function describing the radial distribution of the electric field. Two 30 mm long crystals only 8 x 8 sq mm in cross-section replace a single 35 mm long crystal with a larger 10 x 10 sq mm cross-section. A coaxial E sub 10-mode modulator and a biaxial E sub 20-mode modulator are possible, depending on how the effect of the metal conductors on the electric field distribution is utilized. The biaxial version is preferable for optical microwave range meters and refractometers, being both simpler and more efficient because it requires fewer mirrors behind the receiver optics and smaller metal conductors inside the resonator cavity. The spacing between receiver light beam and transmitter light beam is 35 mm, the tuning range is 120 MHz, and the figure of merit of this modulator is .016 sq rad/W.
Author

**N87-30147#** Joint Publications Research Service, Arlington, Va.
**NONISOTHERMAL INSTABILITY OF HIGH-VELOCITY FLOW OF ELASTOPLASTIC BODIES Abstract Only** **c34**
V. M. Volchkov, A. A. Kozlov, and P. V. Kuzin *In its* USSR Report: Physics and Mathematics 9 Apr. 1987 p 18 Transl. into ENGLISH from Zhurnal Prikladnoy Mekhaniki i Tekhnicheskoy Fiziki (Novosibirsk, USSR), no. 3, May - Jun. 1986 p 133-138 (For primary document see N87-30145 24-70)
Avail: NTIS HC A04/MF A01

Nonisothermal instability of one-dimensional flow is analyzed for elastoplastic bodies, using the equations of one-dimensional flow and heat conduction for a Maxwell or elastoviscous medium and solving these equations for the appropriate boundary conditions. This system of three equations was nondimensionalized by introduction of the Biot number as well as the ration of characteristic heat transfer time to characteristic wave propagation time (elastic waves), the ratio of characteristic heat transfer time to characteric relaxation time (elastic relaxation), and the ratio of characteristic heat transfer time to characteristic heat release time. It was solved by the Runge-Kutta numerical method. Inasmuch as the stability limit does not depend significantly on the ratio of characteristic heat transfer time to characteristic wave propagation time within the N sub Bi = 0.01 to 16 range of the Biot number, it is permissible to omit the equation containing this ratio and solve the system of the remaining two equations with this ratio thus assumed to be zero. This was done by the Galerkin method with use of the QR algorithm, for small perturbations. For an analysis of the nonsteady flow after loss of stability, the complete system of nonlinear equations was solved by the method of finite differences on the basis of integral relations. Author

**N87-30148#** Joint Publications Research Service, Arlington, Va.
**NONLINEAR CONVERSION OF CONTINUOUS RADIATION BY STIMULATED-SCATTERING WAVEGUIDE LASERS Abstract Only** **c36**
Ye. M. Dianov, A. N. Pilipetskiy, A. M. Prokhorov, and V. N. Serkin *In its* USSR Report: Physics and Mathematics 9 Apr. 1987 p 22 Transl. into ENGLISH from Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki (Moscow, USSR), v. 91, no. 4(10), Oct. 1986 p 1249-1261 (For primary document see N87-30145 24-70)
Avail: NTIS HC A04/MF A01

A method is proposed for nonlinear conversion of continuous radiation into a periodic sequence of strong pulses, by a stimulated-scattering laser in a fiber-optic waveguide. The theoretical development of this method is based on numerical solution of the corresponding system of nonlinear partial differential equations which describe the dynamics of radiation emission by such a laser, with a noise field already present and a short triggering pulse within the Stokes region of the noise spectrum available. Continuous radiation is assumed to be pumping the laser, led in through the resonator cavity so as to excite waves propagating in one direction only. Under consideration is both stimulated Mandel'shtam-Brillouin (SMBS) and Raman (SRS) scattering, only excitation of the first Stokes component in each case being considered as a practical matter. Interaction of the radiation field with intrinsic oscillations of the scattering medium, hypersonic and molecular ones, is described by a system of partial differential equations for slowly varying amplitudes of the pumping radiation wave and the first Stokes component. This system of equations is solved for appropriate boundary conditions in the resonator cavity, assuming that at time t = 0 a rectangular pumping pulse of infinitely long duration appears at the cavity entrance. The performance of such a radiation converter will depend on the ratios of SMBS and SRS gain increments as well as on the delay in excitation of a hypersonic wave in the scattering medium.
Author

**N87-30149#** Cincinnati Univ., Ohio.
**ON PERIODIC SOLUTIONS OF AN ATWOOD'S PENDULUM Interim Report, Aug. 1985 - Jul. 1986**
Donald Mittleman May 1987 29 p
(Contract F33615-86-C-3216)
(AD-A183078; AFWAL-TR-87-3006) Avail: NTIS HC A03/MF A01 CSCL 20K

An Atwood's pendulum is defined as an Atwood's machine in which one of two masses is allowed to swing as a pendulum while the other remains constrained to move only in the vertical direction. The pendulum motion of the one mass induces a varying tension in the connecting wire; this, in turn, produces motion in the second mass. It is shown that this motion can be made periodic if the ratio of the two masses and the dependency of this ratio on the initial conditions are chosen as prescribed in this report. If this condition is not met, the motion consists of the superposition of two motions. The first is motion in a constant gravitational field where the effective gravity is kg; the factor k is determined explicitly. The second is the periodic motion that is the central theme of this report. During the course of the analysis, the fundamental frequency of the periodic motion is determined. It is shown to be slightly higher than the frequency of a pendulum of comparable length swinging in the Earth's gravitational field; the factor is given explicitly. This work is restricted to the extent that small approximations are introduced initially for trigonometric functions.
GRA

# 71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

**N87-30150#** Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
**CALCULATION OF NOISE AROUND AIRPORTS FOR POWERED GLIDERS [BEREKENING VAN DE GELUIDSBELASTING RONDOM VLIEGVELDEN GEBRUIKT DOOR MOTORZWEEF-VLIEGTUIGEN]**
G. J. J. Ruijgrok and D. M. vanPaassen Nov. 1985 45 p In DUTCH
(VTH-LR-475; B8707449; ETN-87-90215) Avail: NTIS HC A03/MF A01

The noise in the neighborhood of airports, used only by powered gliders, was estimated using a calculation model. The motor glider GROB-G 109B, which was taken as a characteristic aircraft type, is described with emphasis on its acoustic properties. The noise emission standards, and the equivalent noise level are presented. The calculated noise is presented by means of contours of constant equivalent noise level. The effects of a number of aircraft motions, of flight procedures, and of the strength of the noise source are calculated. ESA

**N87-30151#** Texas Univ., Austin. Applied Research Lab.
**NONLINEAR ACOUSTICS: NONCOLLINEAR INTERACTION, REFLECTION AND REFRACTION, AND SCATTERING OF SOUND BY SOUND Annual Report, 1 Nov. 1986 - 30 Sep. 1987**
David T. Blackstock 24 Jul. 1987 22 p
(Contract N00014-84-K-0574)
(AD-A183180; ARL-TR-87-36) Avail: NTIS HC A02/MF A01 CSCL 20A

Research on four topics in nonlinear acoustics is described. (1) Dependence of three coefficients of nonlinearity for sea water on pressure, temperature, and density. Computation of the coefficients from a combination of theoretical and empirical relations is in progress. (2) Nonlinear, noncollinear interaction of sound waves. Three journal articles have been written, two on interaction in a rectangular waveguide and one on coefficient of nonlinearity for collinear and noncollinear interaction. (3) Reflection and refraction of finite amplitude sound at a plane interface between two fluids. A new form of Snell's law valid for waves of finite amplitude is derived. An experiment to test the implications of the new law is being carried out. (4) Scattering of sound by sound. The classical problem of the secondary radiation produced by interaction of two crossed sound beams is discussed. An experimental test of recent theoretical treatments is in preparation. A preliminary experiment is the measurement of the range dependence of finger lobes in the second harmonic radiation produced in the field of a monochromatically driven piston. GRA

**N87-30152#** Chicago Univ., Ill. Materials Research Lab.
**SOUND POWER MEASUREMENTS IN AIR IN THE NEAR FIELD OF SOUND SOURCES USING THE SOUND INTENSITY METHOD Final Report, 1 Mar. - 1 Oct. 1985**
John R. Polak Oct. 1986 67 p Sponsored by Naval Sea Systems Command, Washington, D.C.
(AD-A183348; DTNSRDC/PAS-86-44) Avail: NTIS HC A04/MF A01 CSCL 17A

Sound power is the acoustic energy output in watts of a sound-producing source. Sound power can be determined with an array of pressure sensing transducers placed around a source in an anechoic chamber. In contrast, sound intensity can be used to measure sound power by measuring the intensity output of the source in watts/sq. m. over a closed surface and using the definition of sound power (intensity X area) to find sound power. Advantages of the sound intensity method are that one measuring probe is used, consisting of two closely placed pressure sensing transducers: no anechoic chamber is needed; measurements can be done in the near field; and background noise can be present. Disadvantages are that: no standards exist yet; and the phase response between the two transducers in the probe must match closely, either through quality transducers or by careful calibration. The two methods of determining sound power were systematically compared. Tests showed that the sound power results from the sound intensity method, even in fairly adverse environments, were comparable to results obtained using the ISO method in most situations. GRA

**N87-30153#** Mississippi Univ., University. Physical Acoustics Research Lab.
**OPTICAL SOUND GENERATION AND AMPLIFICATION Summary Report, 1 Jan. 1984 - 31 Dec. 1986**
Henry E. Bass and F. D. Shields 27 Feb. 1987 14 p
(Contract N00014-84-C-0193)
(AD-A183407; PARGUM-87-01) Avail: NTIS HC A02/MF A01 CSCL 09F

This research has concentrated on sound propagation through a gas with a nonequilibrium distribution of internal states and the generation of sound following excitation of a fluid by a laser. When a sound wave propagates through a gas which has an overpopulation of vibrationally excited states, the wave can increase in amplitude while propagating. In simple terms, this represents a reversal of the absorption typically associated with vibrational relaxation. Amplification of a propagating wave has been theoretically predicted and experimentally observed for a gas undergoing chemical reaction and following an electrical discharge through a non-reacting mixture. Optoacoustic measurements have been completed in gaseous CO2 and SF6 and preliminary results are reported for several liquids. Following laser excitation of SF6 at low pressure, the gas actually cooled. A theoretical model for this behavior consistent with known energy transfer mechanisms has been developed and shown to be consistent with experiment measurements. GRA

**N87-30154#** Naval Ocean Research and Development Activity, Bay St. Louis, Miss.
**HIGH-FREQUENCY ACOUSTIC BOTTOM SCATTERING EXPERIMENTS. PART 1: INSTRUMENTATION AND METHODS Final Report**
J. S. Stanic, P. Fleischer, K. B. Briggs, M. D. Richardson, and B. Eckstein Jan. 1987 48 p
(AD-A183623; NORDA-178-Pt-1) Avail: NTIS HC A03/MF A01 CSCL 17A

NORDA has established an environmental acoustics program that focuses on the relationships between ocean bottom physical properties and acoustic scattering. The program is designed to make environmentally supported acoustic scattering measurements in areas that range from simple and uniform to those that are more complex. With careful site selection it should be possible to correlate changes in ocean bottom physical properties with changes in acoustic scattering strength, correlation and coherence estimates. GRA

**N87-30155*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**ACOUSTIC EFFECTS ON PROFILE DRAG OF A LAMINAR FLOW AIRFOIL**
John G. Shearin, Michael G. Jones (PRC Kentron, Inc., Hampton, Va.), and Robert A. Baals Sep. 1987 18 p
(NASA-TM-100505; NAS 1.15:100505) Avail: NTIS HC A02/MF A01 CSCL 20A

A two-dimensional laminar flow airfoil (NLF-0414) was subjected to high-intensity sound (pure tones and white noise) over a frequency range of 2 to 5 kHz, while immersed in a flow of 240 ft/sec (Rn of 3 million) in a quiet flow facility. Using a wake-rake, wake dynamic pressures were determined and the deficit in momentum was used to calculate a two dimensional drag coefficient. Significant increases in drag were observed when the airfoil was subjected to the high intensity sound at critical sound frequencies. However, the increased drag was not accompanied by movement of the transition location. Author

# 72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

**N87-30156*#** Northeastern Univ., Boston, Mass. Dept. of Chemical Engineering.
**THE IDENTIFICATION OF EXCITED SPECIES IN ARC JET FLOW Summer Faculty Fellowship, 1984**
Ronald J. Willey Houston, Tex. NASA Johnson Space Center 15 Aug. 1987 87 p
(Grant NGP-44-005-803)
(NASA-CR-171990; NAS 1.26:171990) Avail: NTIS HC A05/MF A01 CSCL 20H

Spectrographic work done at the Atmospheric Reentry Material and Structures Facility (arc jet) located at the Johnson Space Center has led to the identification of several excited molecular and atomic states. The excited molecular states identified are: first positive nitrogen system, second positive nitrogen system, the first negative nitrogen system, the gamma system for nitric oxide, and the 306.4 nm system of OH. Excited atoms identified were nitrogen, oxygen, hydrogen, silicon, copper, sodium, barium, potassium, and calcium. The latter five are considered contaminants. Excited molecular states of oxygen were not seen, suggesting full dissociation of oxygen molecules to oxygen atoms within the arc column and nozzle. Further, evidence exists that O(-) may be present since a background continuum is seen, and because of the existence of positive species (first negative system of N2(+)). Interpretation of spectrographic plates was enhanced by the use of a microdensitometer, and by the application of a second order least squares routine which determined wavelength as a function of plate location. Results of this work will ultimately improve models used in the calculation of heat transfer rates to the space shuttle and the aerobraking orbit transfer vehicles.
Author

**N87-30157#** Max-Planck-Inst. fuer Physik und Astrophysik, Munich (West Germany). Werner-Heisenberg-Inst. fuer Physik.
**[ACTIVITIES REPORT OF THE WERNER-HEISENBERG INSTITUTE OF PHYSICS] Annual Report, 1986 [JAHRESBERICHT 1986]**
Jan. 1987 135 p In GERMAN Original contains color illustrations
(ISSN-0173-6256; ETN-87-90311) Copyright Avail: NTIS HC A07/MF A01

Experiments in the European Nuclear Research Center, on the teratron accelerator of the Fermilab, on the electron-positron storage ring PETRA using the CELLO detector, and on the electron-proton storage ring HERA are described. Detectors for low energy neutrinos, electronics for experiments, and data processing and analysis systems were developed. Investigations on particles with charm in hadronic interactions, on light, short-lived particles, on the large electron-positron collider LEP, and on detectors were carried out.
ESA

**N87-30158#** State Univ. of New York, Buffalo.
**COMPUTATIONAL STUDY OF RADIATIVE TRANSITIONS IN MOLECULAR COLLISONS INDUCED BY SHORT LASER PULSES**
Hai-Woong Lee and Thomas F. George 15 Jun. 1987 12 p
(Contract F49620-86-C-0009)
(AD-A182985; AFOSR-87-0867TR) Avail: NTIS HC A02/MF A01 CSCL 20E

A theoretical study of radiative transitions in molecular collisions occurring in the presence of short laser pulses is carried out within the semiclassical two-state formalism. Transition probabilities are calculated by numerically integrating the Bloch equation for two model systems and the Na-Ar system. At high laser intensities where a short pulse is more effective in inducing transitions than cw radiation, the transition probability exhibits nonlinear character with respect to the pulse intensity. At such high intensities, noncollisional atomic transitions may also be present, which need to be eliminated for an observation of collisional transitions.
GRA

**N87-30159#** Naval Research Lab., Washington, D.C.
**EXCITATION AND IONIZATION CROSS SECTIONS FOR ELECTRON-BEAM ENERGY DEPOSITION IN HIGH TEMPERATURE AIR**
Ronald D. Taylor and A. W. Ali 9 Jul. 1987 56 p
(AD-A183074; NRL-MR-6013) Avail: NTIS HC A04/MF A01 CSCL 20H

Electron impact excitation and ionization cross sections for N, N, +, O, and O+ are provided. Electron kinetic energies range from threshold to greater than or = 5 MeV. Available experimental and theoretical are summarized and compared.
GRA

**N87-30160#** Harvard Univ., Cambridge, Mass. Dept. of Chemistry.
**CROSSED MOLECULAR BEAM STUDIES Final Report, 1 Oct. 1981 - 30 Sep. 1984**
D. R. Herschbach Apr. 1987 33 p
(Contract F19628-81-C-0133)
(AD-A183166; AFOSR-87-0210TR) Avail: NTIS HC A03/MF A01 CSCL 07D

Summarized are three investigations: (1) studies of van der Waals collision dynamics; (2) laser spectroscopy study of rotational vibrational relaxations; and (3) angular correlations in chemical reactions. A cross molecular beam apparatus was used to study several van der Waals bond exchange reactions. These collisions involving extremely weak interactions were found to have product velocity distributions which resemble those from several ion molecular reactions which occur at very high collision energy. This led to the theoretical development of a scattering model which should be applicable to a wide range of reactive and inelastic collision processes at kinetic energies higher than the bond strengths. Also, laser induced fluorescence experiments were performed to measure the rotational and vibrational temperatures of molecular iodine seeded in beams of helium, argon, or nitrogen expanded from a supersonic nozzle. The results demonstrated the utility of seeded iodine fluorescence as a diagnostic for pulse shape and collisional relaxation in pulsed supersonic beams. Lastly, theoretical calculations dealing with rotational orientation in molecular collisions resulted in the formulation of a correlation analysis which offers a means to obtain information about collision dynamics that would otherwise be lost by averaging over the initial impact parameters and molecular orientations.
GRA

**N87-30161#** Houston Univ., Tex. Dept. of Chemistry.
**INELASTIC ION-SURFACE COLLISIONS**
J. W. Rabalais 15 May 1987 19 p
(Contract F19628-86-K-0013)
(AD-A183167; AFOSR-87-0206TR; SR-1) Avail: NTIS HC A02/MF A01 CSCL 07D

Ion scattering and direct recoil spectrometries were used to investigate electronic excitation and charge transfer processes occurring during rare gas ion bombardment of CuLi alloy. Excitations in the close encounter appear to be governed by the degree of inner shell mixing between the colliding pair. Excitations in the outgoing trajectory are governed by the probabilities of Auger and resonant charge exchange between the scattered or recoiled particle and the surface. Measurements of the vacuum ultraviolet photon emission of the scattered and recoiled particles proved to be unsuccessful due to low photon yields. The ion induced surface damage to transition metal fluoroanions was investigated by XPS and UPS. Ion bombardment reduces the transition metal atom to lower oxidation states, in some cases all the way to the metal. These results are consistant with the thermal spike model of ion damage.
GRA

**N87-30162#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**THEORY OF LASER-PULSE-INDUCED MOLECULAR DYNAMICS: GAS-PHASE MOLECULAR COLLISIONS AND ADBOND DYNAMICS**
Hai-Woong Lee, Sander VanSmaalen, and Thomas F. George Jul. 1987 16 p
(Contract N00014-86-K-0043)

(AD-A183347; UBUFFALO/DC/87/TR-44) Avail: NTIS HC A02/MF A01 CSCL 07E

A semiclassical study presented here indicates that a sufficiently short and intense pulse can be much more effective in inducing a collisional radiative transition than CW radiation or a long pulse, although the intensity must not be too high because the Rabi oscillation can bring down the probability. For the situation of a molecule physisorbed on a crystalline surface and irradiated by a laser, a master equation approach, used to describe the time evolution of the population of the vibrational adbond levels, shows that for high intensities laser-induced vibrational excitation is the same for pulsed and CW lasers. GRA

**N87-30163#** Stanford Univ., Calif. Dept. of Physics.
**LOW TEMPERATURE STUDIES OF ANOMALOUS SURFACE SHIELDING AND RELATED PHENOMENA Final Report, 15 Nov. 1984 - 14 Nov. 1986**
William M. Fairbank 14 Nov. 1986 37 p
(Grant AF-AFOSR-0023-85)
(AD-A183401; AFOSR-87-0923TR) Avail: NTIS HC A03/MF A01 CSCL 20H

Experiments were conducted to determine the force of gravity on positrons and electrons. An anomalous, low temperature shielding effect was discovered in copper and studied. It is believed that sharp increases in the microwave surface conductivity of copper and aluminum are caused by the appearance of a high mobility surface layer at low temperatures. GRA

**N87-29443*#** Gunma Univ., Maebashi (Japan). Dept. of Mechanical Engineering.
**PARTICLE DATA REDUCTION IN JAPAN**
Mitsushige Nakayama *In* NASA. Ames Research Center, Automated Reduction of Data from Images and Holograms May 1987 p 117-133 (For primary document see N87-29432 24-02) Avail: NTIS HC A99/MF A01 CSCL 20H

# 73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

**N87-30164#** Lawrence Livermore National Lab., Calif.
**GAS-COOLED REACTOR POWER SYSTEMS FOR SPACE**
C. E. Walter 1987 4 p Presented at the 4th Symposium on Space Nuclear Power Systems, Albuquerque, N. Mex., 12 Jan. 1987
(Contract W-7405-eng-48)
(DE86-014449; UCRL-95047; CONF-870102-1) Avail: NTIS HC A02/MF A01

The characteristics of six designs for power levels of 2, 10, and 20 MWe for operating time of 1 and 7 years are described. The operating conditions for these arbitrary designs were chosen to minimize system specific mass. The designs are based on recent work which benefits from earlier analyses of nuclear space power systems conducted at LLNL. Both gas and liquid cooled reactors had been considered. Pitts and Walter reported on the results of a detailed study of a 10 MWe lithium cooled reactor in a potassium Rankine system. Unpublished results of a computer analysis provide details of an argon cooled reactor in an argon Brayton system. The gas cooled reactor design was based on extensive development work on the 500 MWth reactor for the nuclear ramjet (Pluto) as described by Walter. The designs discussed here draw heavily on the Pluto project experience, which culminated in a successful full power ground test as reported by Reynolds. At higher power levels gas cooled reactors coupled with Brayton systems with advanced radiator designs becomes attractive. GRA

**N87-30165#** Argonne National Lab., Ill.
**INTERACTION OF THE CONTROL SYSTEM WITH CORE NUCLEAR DESIGN FOR FAST SPECTRUM SPACE POWER REACTORS**
Richard M. Lell and Nelson A. Hanan 1987 23 p Presented at the 4th Symposium on Space Nuclear Power Systems, Albuquerque, N. Mex., 12-16 Jan. 1987
(Contract W-31109-eng-38)
(DE87-006987; CONF-870102-15) Avail: NTIS HC A02/MF A01

Generic features of the interaction between core nuclear and mechanical designs and reactor control system design for compact fast spectrum space power reactors have been examined. Reactivity worths of various control concepts were evaluated for representative fast spectrum cores. In addition, special characteristics of each control concept that significantly affect core nuclear and mechanical design were considered. Ex-core control methods based on reflector control and in-core control devices such as control rods lead to divergent core designs and to different types of design problems. Total control worth of ex-core control devices is limited and is strongly dependent on core size. Reflector control also results in unfavorable radial power shifts, but ex-core control does avoid unnecessary reactor vessel penetrations. Control rods have characteristics essentially opposite to those of ex-core devices. Design demands on the primary control system are shown to be reduced by including a slow-acting secondary system based on in-core dispersed poison. DOE

**N87-30166#** Pacific Northwest Labs., Richland, Wash.
**TWO-PHASE REDUCED GRAVITY EXPERIMENTS FOR A SPACE REACTOR DESIGN**
Z. I. Antoniak Aug. 1986 9 p Presented at the Microgravity Fluid Management Symposium, Cleveland, Ohio, 9 Sep. 1986
(Contract DE-AC06-76RL-01830)
(DE86-015530; PNL-SA-14228; CONF-8609146-1) Avail: NTIS HC A02/MF A01

Future space missions envision the use of large nuclear reactors utilizing either a single or a two-phase alkali-metal working fluid. The design and analysis of such reactors require state-of-the-art computer codes that can properly treat alkali-metal flow and heat transfer in a reduced-gravity environment. New flow regime maps, models, and correlations are required if the codes are to be successfully applied to reduced-gravity flow and heat transfer. General plans are put forth for the reduced-gravity experiments which will have to be performed, at NASA facilities, with benign fluids. Data from the reduced-gravity experiments with innocuous fluids are to be combined with normal gravity data from two-phase alkali-metal experiments. Because these reduced-gravity experiments will be very basic, and will employ small test loops of simple geometry, a large measure of commonality exists between them and experiments planned by other organizations. It is recommended that a committee be formed, to coordinate all ongoing and planned reduced gravity flow experiments. DOE

**N87-30167#** Pacific Northwest Labs., Richland, Wash.
**TWO-PHASE COMPUTER CODES FOR ZERO-GRAVITY APPLICATIONS**
W. J. Krotiuk Oct. 1986 13 p Presented at the 33rd Annual Meeting of the American Astronautical Society - Aerospace: Century 21, Boulder, Colo., 27 Oct. 1986
(Contract DE-AC06-76RL-01830)
(DE87-002711; PNL-SA-14372; CONF-8610219-1) Avail: NTIS HC A02/MF A01

This paper discusses the problems existing in the development of computer codes which can analyze the thermal-hydraulic behavior of two-phase fluids especially in low gravity nuclear reactors. The important phenomenon affecting fluid flow and heat transfer in reduced gravity is discussed. The applicability of using existing computer codes for space applications is assessed. Recommendations regarding the use of existing earth based fluid flow and heat transfer correlations are made and deficiencies in these correlations are identified. DOE

**N87-30168#** Argonne National Lab., Ill.
**EFFECTS OF SPACE-DEPENDENT CROSS SECTIONS ON CORE PHYSICS PARAMETERS FOR COMPACT FAST SPECTRUM SPACE POWER REACTORS**
R. M. Lell and N. A. Hanan 1987 17 p Presented at the 4th Symposium on Space Nuclear Power Systems, Albuquerque, N. Mex., 12 Jan. 1987
(Contract W-31-109-eng-38)
(DE87-006985; CONF-870102-14) Avail: NTIS HC A02/MF A01

Effects of multigroup neutron cross section generation procedures on core physics parameters for compact fast spectrum reactors have been examined. Homogeneous and space-dependent multigroup cross section sets were generated in 11 and 27 groups for a representative fast reactor core. These cross sections were used to compute various reactor physics parameters for the reference core. Coarse group structure and neglect of space-dependence in the generation procedure resulted in inaccurate computations of reactor flux and power distributions and in significant errors regarding estimates of core reactivity and control system worth. Delayed neutron fraction was insensitive to cross section treatment, and computed reactivity coefficients were only slightly sensitive. However, neutron lifetime was found to be very sensitive to cross section treatment. Deficiencies in multigroup cross sections are reflected in core nuclear design and, consequently, in system mechanical design. DOE

**N87-30169#** Sandia National Labs., Albuquerque, N. Mex.
**THE EFFECT OF OPERATING TEMPERATURE ON OPEN, MULTIMEGAWATT SPACE POWER SYSTEMS**
M. W. Edenburn 1987 33 p Presented at the 4th Symposium on Space Nuclear Power Systems, Albuquerque, N. Mex., 12 Jan. 1987
(Contract DE-AC04-76DP-00789)
(DE87-011311; SAND-86-1813C; CONF-870102-26) Avail: NTIS HC A03/MF A01

This study addresses reactor powered and combustion powered multimegawatt, burst mode, space power systems to evaluate the effect turbine inlet temperature will have on their performance and mass. Both systems will provide power to space based antiballistic missile weapons that require hydrogen for cooling, and both use this hydrogen coolant as a working fluid or as a fuel for power generation. The quantity of hydrogen needed for weapon cooling increases as the weapon's cooling load increases and as weapon coolant outlet temperature decreases. Also, the hydrogen needed by the turbines in both power systems increases as turbine inlet temperature decreases. When weapon cooling loads are above 40% to 50% of weapon power and weapon coolant outlet temperature is below 300 K to 400 K, the weapon needs more hydrogen than the turbine in either the reactor or combustion powered systems using turbine inlet temperatures consistent with current material technology. There is therefore very little system mass reduction to be gained by operating a burst mode power system at a turbine inlet temperature above present material temperature limits unless the weapon's cooling load is below 40% to 50% or coolant outlet temperature is above 300 K to 400 K. Furthermore, the combustion system's mass increases as turbine inlet temperature increases because oxygen inventory increases with increased turbine inlet temperature. DOE

**N87-30170#** Kernforschungsanlage, Juelich (West Germany). Zentralabteilung fuer Allgemeine Technologie.
**UNSTEADY TEMPERATURE DEVELOPMENT AND DEFORMATION OF COPPER PLATES WITH A ONE-SIDED HEAT FLUX, USED AS TARGETS FOR NEUTRAL BEAM INJECTION**
Herbert Bousack and Peter Wilhelm Phlippen Jul. 1986 123 p In GERMAN; ENGLISH summary
(JUEL-2078; ISSN-0366-0885; ETN-87-90340) Avail: NTIS HC A06/MF A01

The heat-engineering design of plate-type targets, subject to a one-sided heat flux from neutral beam injectors in fusion reactors, was performed. Analytic equations were compiled to calculate the unsteady temperature evolution for the one-dimensional case. A finite difference program was developed for the calculation of the exact three-dimensional unsteady temperature field produced by a two-dimensional power density distribution. The plastic properties of the material can be used for the determination of the stresses and deformations, based on the computed temperature field. Calculations were carried out for a copper target of the neutral beam injector of the TEXTOR pilot facility, and the results were compared with experimental results and a scaled-down model. The results from the experimental cooling of hot cooling plates, and a simple computation method are presented. ESA

**N87-30171#** Naval Research Lab., Washington, D.C.
**GUIDING OF ELECTRON BEAMS BY HOLLOW CONDUCTING CHANNELS**
R. F. Fernsler and B. Hui 30 Jul. 1987 48 p
(AD-A183693; NRL-MR-6011) Avail: NTIS HC A03/MF A01 CSCL 09A

The use of hollow conducting channels to guide relativistic electron beams through dense gases is explored theoretically. The channel conditions needed to effect strong guidance are determined from analytic and numerical computations of the transverse force felt by a beam uniformly displaced but propagating inside the channel. The force is shown to be strong in the beam head but weak in the beam body. Several different channel configurations are considered, and various effects that can degrade channel guidance are discussed. GRA

# 74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.*

**N87-30172#** Stanford Linear Accelerator Center, Calif.
**THE MICROLASERTRON: AN EFFICIENT SWITCHED-POWER SOURCE OF mm WAVELENGTH RADIATION**
R. B. Palmer Dec. 1986 12 p Presented at the Advanced Accelerator Concepts Conference, Madison, Wis., 21 Aug. 1986 Prepared in cooperation with BNL, Upton, N.Y.
(Contract DE-AC03-76SF-00515)
(DE87-010539; SLAC-PUB-3890-Rev; CONF-8608123-11-Rev)
Avail: NTIS HC A02/MF A01

An extension of W. Willis' Switched Power Linac is studied. Pulsed laser light falls on a photocathode wire, or wires, within a simple resonant structure. The resulting pulsed electron current between the wire and the structure wall drives the resonant field, and RF energy is extracted in the mm to cm wavelength range. Various geometries are presented, including one consisting of a simple array of parallel wires over a plane conductor. Results from a one-dimensional simulation are presented. DOE

**N87-30173#** California Univ., Berkeley. Lawrence Berkeley Lab.
**DIAMOND-LIKE ANTIREFLECTIVE COATINGS FOR FAR INFRARED PHOTOCONDUCTORS**
J. W. Beeman, A. R. Nyaiesh, E. E. Haller, W. L. Hansen, and E. L. Garwin May 1987 6 p Presented at the European Materials Research Society Conference, Strasbourg, France, 2 Jun. 1987 Prepared in cooperation with Stanford Linear Accelerator Center, Menlo Park, Calif.
(Contracts DE-AC03-76SF-00515; DE-AC03-76SF-00098)
(DE87-012836; SLAC-PUB-4309; CONF-8706152-2) Avail: NTIS HC A02/MF A01

Diamond-like films have been used as antireflective coatings on far infrared semiconductor photoconductors. An average increase in the detector responsivity of 28 percent was realized for optimally coated gallium-doped germanium photoconductors compared to uncoated devices. The photoconductors were operated at 3 K without cavity in a narrow wavelength range from 98.45 to 99.35 microns . The films survived repeated thermal cycling between room temperature and 2.5 K. Any increase in dark current caused by the coating is less than or equal to 10 to

the -14 A, a value which is given by instrumentation. The protective qualities of the film are explored. The potential applications of diamond-like coated photoconductors in large, unstressed and stressed arrays which will be used in future, satellite-born astrophysics missions will be discussed. DOE

**N87-30174#** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Unternehmensgruppe Raumfahrt.
**STRAY LIGHT STUDY: EXPERIMENTAL METHODS FOR STRAY LIGHT SUPPRESSION BY BAFFLED IR TELESCOPES Final Report, Apr. 1985**
Sigmund Manhart Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 56 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(Contract BMFT-0100-0345)
(BMFT-FB-W-86-025; ISSN-0170-1339; ETN-87-90327) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 11.50

The feasibility of stray light suppression in a warm environment was studied, via the example of the fully baffled German Infrared Laboratory telescope. The requirements for astronomy and aeronomy operation modes were defined. The limiting background effects during warm tests were analyzed. The available radiation sources and detectors were identified. Tests at a systems level appear unfeasible within acceptable efforts. Therefore, it is proposed to perform tests at component and/or subsystem level at discrete wavelengths, and to couple the results analytically in order to obtain the systems performance. ESA

**N87-30175#** Karlsruhe Univ. (West Germany). Inst. fuer Stroemungslehre und Stroemungsmaschinen.
**OPTICAL LABORATORY: EXPERIMENTAL INVESTIGATION OF THERMAL CONVECTION IN SQUARE AND CYLINDRICAL CELLS Final Report, Sep. 1985**
Karl-Reiner Kirchartz, Gerhard Seiler, and Juergen Zierep Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 94 p In GERMAN; ENGLISH summary Sponsored by Bundesministrium fuer Forschung und Technologie
(BMFT-FB-W-86-027; ISSN-0170-1339; ETN-87-90329) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 19.50

Model investigations with simplified boundary conditions were performed in square and cylindrical cells to reveal the nature of convective instabilities in crystal melts. The aspect ratio length-to-height was varied between 6:1 and 1:4, with special attention to the case 1:1. Optical measuring techniques (differential interferometer, laser differential interferometer, streakline photography, laser Doppler anemometry) and a thermocouple measuring system were used to visualize the flow structure, and to determine the temperature and velocity field. For selected parameters, the three-dimensional flow field was calculated using an explicit finite difference method. The influence of the Rayleigh and Prandtl number, as well as of the boundary and initial conditions on the development of steady and time dependent solutions is discussed. The results are an important basis for the understanding of thermal instabilities in crystal melts. ESA

**N87-30176#** Optical Technologies, Inc., Herndon, Va.
**FIBER-OPTIC ENGINEERING SENSOR SYSTEM Final Report**
1987 128 p
(Contract N00014-87-C-2033)
(AD-A182900) Avail: NTIS HC A07/MF A01 CSCL 20F

The conceptual design for a fiber-optic engineering sensor system adaptable to many Navy systems is presented. The sensor system consists of the following components: (1) A variety of amplitude type fiber optic sensors, each designed to measure a different physical parameter; (2) Optoelectronic circuitry to control the fiber optic sensors; and (3) A local fiber optic telemetry subsystem that communicates sensor data to other ships' equipment. Details of the sensor system design along with the advantages and potential risks of the proposed system are discussed. Primary advantages are the introduction of standard interface between existing ship's equipment and a large variety of sensor types, increased performance and system flexibility, and reduced sensor size, weight, and cost. Presented is an evaluation of the sensor and data telemetry requirements of the propulsion control system of the DDG-51. Specifically addressed is the Shaft Control Unit (SCU) of that system. The SCU has been selected as a design model because it represents the current state of control system architecture and appears to be an ideal application for the introduction of fiber optic systems. GRA

**N87-30177#** NKF Engineering, Inc., Reston, Va.
**FIBER OPTIC ENGINEERING SENSOR SYSTEM CONCEPT DESIGN REVIEW DATA PACKAGE**
Apr. 1987 199 p
(Contract N00014-87-C-2032)
(AD-A183081; NKF-87103-001/5) Avail: NTIS HC A09/MF A01 CSCL 20F

The use of fiber optic technology in shipboard IC systems has several conceptual advantages over existing systems including improved reliability, weight savings, and advanced signal quality. Our analysis of mission needs leads us to the conclusion that the following design elements are paramount from the aspect of satisfactory mission performance. The sub-systems chosen for application of fiber optic technology are generally those which involve monitoring of dynamic systems or security check points and the subsequent sounding of appropriate signals when alarm conditions occur. Clearly these systems must be extremely reliable, but in addition to the more typical failure criteria associated with system breakdown, the Fiber Optic Engineering Sensor System (FOESS) must be accurate; i.e., there must be a minimum of false alarm signals transmitted to the operators else the alarm system will soon be ignored, or worse, deenergized. Philosophically, the desired FOESS reliability (defined as the probability that the system will be in a satisfactory operating condition at a random point in time) should approach unity; likewise, the probability of false alarms should approach zero. GRA

**N87-30178#** NKF Engineering, Inc., Reston, Va.
**FIBER OPTIC ENGINEERING SENSOR SYSTEM, PHASE 1 Final Technical Report**
Apr. 1987 20 p
(Contract N00014-87-C-2032)
(AD-A183082; NKF-87103-001/6) Avail: NTIS HC A02/MF A01 CSCL 20F

The results and recommendations of the NKF team activity conducted in support of NRL to develop a conceptual Fiber Optic Engineering Sensor System design are discussed. A conceptual overall system, which may be derived from a number of component choices, is described. In summary, its main characteristics are: A two-piece sensor, comprising a transducer and a conversion module. Four choices of transducer are given, two from each of two families. A telemetry design combining dichroic ratiometry with common carrier architecture, and a control/display design based on a microcomputer used as a process controller and providing built-in testing facilities. The report recommends: that a universal transducer be developed rather than transducers specific to each sensing function; the construction of one transducer from each family and the testing of both to eliminate the weakest; the construction and testing of at least one conversion module, there would be R and D advantages in fabricating additional types of conversion modules; the construction and testing of hitherto untested key telemetry components, and the investigation and evaluation of an optimum network architecture to further increase system cost savings. GRA

**N87-30179#** Arizona Univ., Tucson.
**MASKING OF LIGHT SCATTERING INFORMATION Contractor Report, Sep. 1984 - Oct. 1986**
William S. Bickel Jun. 1987 58 p
(Contract DAAK11-84-K-0012)
(AD-A183417; CRDEC-CR-87089) Avail: NTIS HC A04/MF A01 CSCL 20F

The author and his students have carried out numerous measurements to explore polarized light scattering from spheres, fibers, and variously prepared surfaces. This report summarizes the results of those investigations and directs the reader to sources in which detailed descriptions of the separate studies have been published. GRA

**N87-30180*#** Ohio State Univ., Columbus. ElectroScience Lab.
**DESIGN, IMPLEMENTATION AND INVESTIGATION OF AN IMAGE GUIDE-BASED OPTICAL FLIP-FLOP ARRAY**
P. C. Griffith Jul. 1987 99 p
(Grant NsG-3302)
(NASA-CR-181382; NAS 1.26:181382; ESL-TR-712257-5) Avail: NTIS HC A05/MF A01 CSCL 20F

Presented is the design for an image guide-based optical flip-flop array created using a Hughes liquid crystal light valve and a flexible image guide in a feedback loop. This design is used to investigate the application of image guides as a communication mechanism in numerical optical computers. It is shown that image guides can be used successfully in this manner but mismatch match between the input and output fiber arrays is extremely limiting. Author

**N87-29476#** British Aerospace Public Ltd. Co., Bracknell (England). Electronic Systems and Equipment Div.
**THE BAe (BRACKNELL) AUTOMATIC DETECTION, TRACKING AND CLASSIFICATION SYSTEM**
C. J. Samwell and G. A. Cain *In* AGARD, Advances in Guidance and Control Systems and Technology Jul. 1987 10 p (For primary document see N87-29474 24-04)
Copyright Avail: NTIS HC A07/MF A01

**N87-29561#** Joint Publications Research Service, Arlington, Va.
**DETERMINING INTERVALS AND DATES OF ONSET OF CRITICAL ILLUMINATION CONDITIONS FOR SPACECRAFT INSTRUMENTS Abstract Only**
I. D. Ibragimov and B. S. Shrebushevskiy *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 46 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 141-147 Original language document was announced in IAA as A87-34221 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-30146#** Joint Publications Research Service, Arlington, Va.
**MICROWAVE LIGHT MODULATORS WITH SPACED CRYSTALS Abstract Only**
K. S. Gyunashyan, V. A. Papyan, and M. K. Sagatelyan *In its* USSR Report: Physics and Mathematics 9 Apr. 1987 p 14-15 Transl. into ENGLISH from Izvestiya Akademii Nauk Armyanskoy SSR: Seriya Tekhnicheskikh Nauk (Yerevan, USSR), v. 39, no. 3, May - Jun. 1986 p 24-27 (For primary document see N87-30145 24-70)
Avail: NTIS HC A04/MF A01

# 75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

**N87-30181#** California Univ., Berkeley. Lawrence Berkeley Lab.
**CONGRUENT REDUCTION AND MODE CONVERSION IN 4-DIMENSIONAL PLASMAS**
L. Friedland and A. N. Kaufman Apr. 1987 7 p Presented at the 7th Topical Conference on Applications of Radio-Frequency Power to Plasmas, Kissimmee, Fla., 4 May 1987
(Contract DE-AC03-76SF-00098)
(DE87-010263; LBL-23299; CONF-870570-10) Avail: NTIS HC A02/MF A01

Standard eikonal theory reduces, to N=1, the order of the system of equations underlying wave propagation in inhomogeneous plasmas. The condition for this remarkable reducibility is that only one eigenvalue of the unreduced NxN dispersion matrix D(k,x) vanishes at a time. If, however, two or more eigenvalues of D become simultaneously small, the geometric optics reduction scheme becomes singular. These regions are associated with linear mode conversion, and are described by higher order systems. A new reduction scheme based on congruent transformations of D is developed, and it is shown that, in degenerate plasma regions, a partial reduction of order is possible. The method comprises a constructive step-by-step procedure, which, in the most frequent (doubly) degenerate case, yields a second order system, describing the pairwise mode conversion problems, the solution of which in general geometry has been found recently. DOE

**N87-30182#** Massachusetts Inst. of Tech., Cambridge. Plasma Fusion Center.
**PROSPECTS FOR FUSION: THE WINDS OF CHANGE**
R. C. Davidson 1987 18 p Presented at the Annual Meeting of Fusion Power Associates, Pleasanton, Calif., 8 Apr. 1987
(DE87-900826; PFC/CP-87-1; CONF-870457-2) Avail: NTIS HC A02/MF A01

This paper addresses the following topics: (1) national energy circumstances and policy, and the implications for fusion; (2) the intrinsic merit of fusion research and development as it contributes to the national science and technology base; (3) the research opportunities and priorities in inertial confinement fusion; and (4) the research opportunities and priorities in magnetic fusion. DOE

**N87-30183#** Lawrence Livermore National Lab., Calif.
**DESIGNING THE CASCADE INERTIAL CONFINEMENT FUSION REACTOR**
John H. Pitts Feb. 1987 7 p Presented at the 9th SMIRT: International Conference on Structural Mechanics in Reactor Technology, Lausanne, Switzerland, 17 Aug. 1987
(Contract W-7405-eng-48)
(DE87-006240; UCRL-95021; CONF-870812-7) Avail: NTIS HC A02/MF A01

The primary goal in designing inertial confinement fusion (ICF) reactors is to produce electrical power as inexpensively as possible, with minimum activation and without compromising safety. This paper discusses a method for designing the Cascade rotating ceramic-granule-blanket reactor (Pitts, 1985) and its associated power plant (Pitts and Maya, 1985). Although focus is on the cascade reactor, the design method and issues presented are applicable to most other ICF reactors. DOE

**N87-30184** Max-Planck-Inst. fuer Plasmaphysik, Garching (West Germany).
**[ACTIVITIES REPORT IN PLASMA PHYSICS] Annual Report, 1985-86 [JAHRESBERICHT 1985/86]**
1986 65 p In GERMAN Original contains color illustrations
(ISSN-0172-8482; ETN-87-90319) Copyright Avail: Fachinformationszentrum, Karlsruhe, West Germany

The history of 25 years of the Institute of Plasmphysics (IPP) is depicted. The organization of the IPP, and its tasks in the fields of nuclear fusion (an international task) and the German fusion program, are described. The fundamentals of nuclear fusion, magnetic field configurations, and experimental arrangements, and the elements of fusion experiments are presented. The experimental and theoretical results in the fields of tokamak and stellarator research are summarized. ESA

**N87-30185#** Arizona Univ., Tucson. Dept. of Chemistry.
**A HIGH PRESSURE INDUCTIVELY COUPLED PLASMA TORCH Interim Report**
Thomas R. Smith and M. B. Denton 26 May 1987 20 p
(Contract N00014-86-K-0316)
(AD-A183212; TR-47) Avail: NTIS HC A02/MF A01 CSCL 20I

An Inductively Coupled Plasma (ICP) torch utilizing an extended coolant tube that tapers down to a small exit orifice designed to increase the pressure within the ICP torch is described. This torch

design makes use of the advantages associated with higher torch operating pressures, including improved detection limits, increased sensitivity and better plasma stability, without requiring major modifications to existing commercially available ICP torch box and matching networks. Detection limits obtained utilizing the new torch design are compared to those obtained from several commonly used torch designs using a commercially available torch box and spectrometer. A two- to seven- fold improvement in detection limits is observed through increasing torch operating pressure from 101.325 KPa (760 torr, or atmospheric pressure) to 120 KPa(900 torr). GRA

**N87-30186#** California Univ., Berkeley. Electronics Research Lab.
**ARTIFICIAL COOLING DUE TO QUIET INJECTION IN BOUNDED PLASMA PARTICLE SIMULATIONS**
William S. Lawson 21 May 1987 22 p
(Contracts N00014-85-K-0809; DE-AT03-76ET53064)
(AD-A183324; UCB/ERL-M87/34) Avail: NTIS HC A02/MF A01 CSCL 20I

An explanation is proposed for an artificial cooling effect seen in electrostatic particle-in-cell plasma simulations. Further simulations are done which test and support the explanation. GRA

**N87-30187#** California Univ., Los Angeles. Center for Plasma Physics and Fusion Engineering.
**EQUILIBRIUM AND WAVE PROPERTIES OF TWO-DIMENSIONAL ION PLASMAS**
S. A. Prasad and G. J. Morales Jun. 1987 52 p
(Contract N00014-75-C-0476)
(AD-A183570; PPG-1077) Avail: NTIS HC A04/MF A01 CSCL 20M

Recent experiments have demonstrated the existence of collective modes in a two-dimensional single component ion layer residing just below the surface of liquid helium. A theory of the equilibrium and the wave properties of such a system is presented. The equilibrium is calculated by balancing the repulsive self-electric field pressure with the confining external electric field. In the limit of temperature T = O, the plasma is in the form of a constant density disk at the edge of which the density decreases to zero with a scale length set by the dimensions of the enclosing cylindrical box; increasing T increases the width of the transition region. Modelling the ions as a cold two-dimensional fluid, it is found that the plasma supports an infinite set of radial modes for each value of L, the azimuthal mode number. Imposition of a constant magnetic field perpendicular to the charge sheet increases the frequency of the L = O modes and for L does not = O, splits each mode into two; the lowest of these split modes is related to the diocotron mode. GRA

**N87-30188#** Naval Research Lab., Washington, D.C.
**ONSET CRITERIA FOR STRUCTURE IN MAGNETICALLY CONFINED PLASMA EXPANSIONS**
J. D. Huba 9 Jul. 1987 22 p
(AD-A183691; NRL-MR-6030) Avail: NTIS HC A02/MF A01 CSCL 20I

A set of criteria is proposed for the onset of structure caused by the unmagnetized ion Rayleigh-Taylor instability in magnetically confined plasma expansions. R sub C, the critical radius at which structure can begin to develop, is independent of the magnetic field. There is a critical value of laser energy that needs to be exceeded for structure to develop. GRA

**N87-30189*#** Alabama Univ., Huntsville. Coll. of Science.
**INVESTIGATION OF LOW ENERGY SPACE PLASMA Semiannual Progress Report, Apr. - Sep. 1987**
Richard H. Comfort and James L. Horwitz Oct. 1987 14 p
(Grant NAG8-058)
(NASA-CR-181380; NAS 1.26:181380) Avail: NTIS HC A02/MF A01 CSCL 20I

An important modification was made in the method for computing ion densities from DE1/RIMS observations, based on the observed relationship between total plasma density and spacecraft potential. An iterative technique was developed to require that this relationship be preserved in all individual observations, not just in the average sense observed. Results of employing this technique were examined closely and are found to generally improve the final densities in terms of agreement with densities obtained from PWI upper hybrid frequency observations. It also has the effect of reducing scatter in the density vs. L profiles. B.G.

# 76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**N87-30190#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
**IMPURITY BAND IN AN INVERSION LAYER M.S. Thesis - 27 Nov. 1986 [BANDA DE IMPUREZA EM CAMADA DE INVERSAO]**
Erasmo AssumpcaodeAndradaeSilva Jun. 1987 102 p In PORTUGUESE; ENGLISH summary
(INPE-4188-TDL/275) Avail: NTIS HC A06/MF A01

The electronic states associated with impurities in MOS systems are studied. The averaged density of states of the impurity band in the randomly distributed impurities system is calculated for several values of the applied electric field and of the impurity concentration. The Hubbard model is used for the electron system and the configurational disorder is treated within the Matsubara and Toyozawa scheme. The variational solution of Martin and Willis is used for the one electron bound state problem. The results of the bandwidth and the maximum density of states are compared with the experimental values of Hartstein and Fowler and better agreement exists than in early works. In a first approach, the interaction between impurities is also studied. The density of molecular states associated with pairs of impurities is calculated. A simple model of pair formation between nearest neighbors impurities is considered. The separation between the impurities obeys a Poisson distribution. The molecular electronic states were obtained by the Variational Alternant Molecular Orbital Method (VAMO). Author

**N87-30191#** California Univ., Berkeley. Lawrence Berkeley Lab.
**SUCCESSFUL MOLECULAR BEAM EPITAXY GROWTH AND CHARACTERIZATION OF (110) GaAs/GaAs AND (110) AlGaAs/GaAs Ph.D. Thesis**
L. P. Allen Mar. 1987 104 p
(Contract DE-AC03-76SF-00098)
(DE87-010985; LBL-23427) Avail: NTIS HC A06/MF A01

Commonly observed faceting of (110) GaAs films grown by molecular beam epitaxy (MBE) has been analyzed. Facets were studied with respect to MBE growth parameters, the GaAs crystallography, their chemical, electrical, and optical nature, and the kinetics of initial formation. Facets were found to align along the (001) with side planes of (100) and (010). The back planes of the facets were consistently of (111) Ga in nature. The facets were composed of stoichiometric GaAs but resulting films were of poor optical and electrical quality. By exposing an abundance of Ga ledges on the substrate surface, the faceting of the MBE (110) GaAs surface was eliminated. This systematic approach has, for the first time, allowed facet free epitaxy growth of (110) GaAs and (110) AlGaAs/GaAs superlattices. Facet free MBE films were examined by Hall effect, photoluminescence, deep level transient spectroscopy, and transmission electron microscopy. A model of (110) GaAs facet initiation, development, and elimination is presented. DOE

**N87-30192#** Midwest Research Inst., Golden, Colo.
**SOLID STATE PHOTOVOLTAIC RESEARCH BRANCH Annual Report, FY 1986**

Jun. 1987 212 p
(Contract DE-AC02-83CH-10093)
(DE87-001163; SERI/PR-212-3140) Avail: NTIS HC A10/MF A01

This report summarizes the progress of the Solid State Photovoltaic Research Branch of the Solar Energy Research Institute (SERI) from 1 October 1985 through 30 September 1986. Five technical sections of the report cover these main areas of SERI's in-house photovoltaic research: Semiconductor Crystal Growth, Amorphous Silicon Research, Polycrystalline Thin Films, III-V High-Efficiency Photovoltaic Cells, and Solid State Theory. A short sixth section covers some of the work done under the PV Renowned Scientist Program at SERI. The task in each case was to explain the purposes and major accomplishments of the work in the context of the US Department of Energy's National Photovoltaic Program's research plans. DOE

**N87-30193#** Lawrence Livermore National Lab., Calif.
**THE SURFACE TOPOGRAPHY OF PYROLITIC CARBONS AND OF Au THIN FILMS BY SCANNING TUNNELING MICROSCOPY: GRAIN BOUNDARIES AND SURFACE DEFECTS**
M. Salmeron, B. Marchon, S. Ferrer, D. S. Kaufman, and W. Siekhaus 27 Apr. 1987 19 p Presented at the International Conference on Metallurgical Coatings, San Diego, Calif., 23 Mar. 1987 Prepared in cooperation with California Univ., Berkeley, Lawrence Berkeley Lab.
(Contract W-7405-eng-48)
(DE87-009739; UCRL-96576; CONF-870388-6; LBL-23149)
Avail: NTIS HC A02/MF A01

We have shown using STM that Au thin films (approx. = 10 nm) deposited on mica have a smoothly rolling hill structure that can be flattened to the atomic level by mild (250 C) annealing. This treatment resulted in a film surface with extended regions of several hundred nm where the only departures from the atomic surface plane are isolated steps of monoatomic height. Residual bumps and trenches are the only imperfections on the scale of nm. The surface topography of pyrolitic carbons prepared at various temperatures revealed crystallite sizes and orientation in approximate agreement with X-ray data. Grain boundaries between the various crystallites were examined and revealed that the extent of the transition region varies from sharp atomic dimensions to several tens of nm wide. Defects in the form of steps and localized points are observed in the center of the otherwise atomically smooth crystallite surfaces. Atomically resolved images of the crystallite surface indicate a periodicity consistent with the missing atom observations on graphite. DOE

**N87-30194#** Brookhaven National Lab., Upton, N. Y.
**MECHANISMS OF ORGANIC SUPERCONDUCTIVITY**
V. J. Emery 1986 6 p Presented at the Low-Dimensional Conductors and Superconductors, Quebec, 24 Aug. 1986 Prepared in cooperation with IBM Research Lab., Zurich, Switzerland
(Contract DE-AC02-76CH-00016)
(DE87-011294; BNL-39911; CONF-8608146-2) Avail: NTIS HC A02/MF A01

A model of organic superconductors is based on pairing involving electrons on different organic stacks and taking into account the second band of hole states. DOE

**N87-30195#** Argonne National Lab., Ill.
**SURFACE MAGNETO-OPTICAL STUDIES OF FERROMAGNETIC FILMS**
S. D. Bader and E. R. Moog Feb. 1987 36 p Presented at the American Institute of Metallurgical Engineers Annual Meeting: Light Metals Session, Denver, Colo., 22 Feb. 1987
(Contract W-31-109-eng-38)
(DE87-011491; CONF-870272-5) Avail: NTIS HC A03/MF A01

The magneto-optic Kerr effect is used to characterize the magnetic properties of epitaxial ferromagnetic films whose thickness includes the monolayer range. The studies are performed in ultra-high vacuum with LEED-Auger auxiliary characterizations to monitor the epitaxy and growth-mode behavior. Results are summarized for Fe deposited on Au(100) and Cu(100) to stabilize the bcc and fcc Fe phases, respectively. The most striking finding is the observation of a new, metastable ferromagnetic state at the surface of paramagnetic fcc-Fe/Cu(100) above room temperature. The observation is discussed in terms of a double minimum in the interlayer surface relaxation (with the expanded state being ferromagnetic and contracted state not) as supported by recent independent LEED measurements. DOE

**N87-30196#** Arizona Univ., Tucson.
**FABRICATION AND FUTURE OF METALLIC SUPERLATTICES**
C. M. Falco 1987 9 p Presented at the 3rd International Conference on Modulated Semiconductor Structure, Montpelier, France, 6 Jul. 1987
(Contract DE-FG02-87ER-45297)
(DE87-012726; DOE/ER-45297/3; CONF-870761-2) Avail: NTIS HC A02/MF A01

Research on metallic multilayers and superlattices is reviewed. The types of layered structures of interest for metals are described. The principal techniques used to prepare these materials are described, and examples of applications are given. DOE

**N87-30197#** Arizona Univ., Tucson. Dept. of Physics.
**SUPERCONDUCTING METALLIC SUPERLATTICES**
C. M. Falco, R. Vaglio, and A. M. Cucolo 1987 8 p Prepared in cooperation with Salerno Univ., Italy
(Contract DE-AC02-83ER-45025)
(DE87-012742; DOE/ER-45025/17) Avail: NTIS HC A02/MF A01

Since the coherence length is of order 50 A to 1 m, it is possible to alternately layer thin films of a superconductor with another material to affect the physical properties of the resulting superlattice. A brief description of our sputtering technique used to prepare superlattices consisting of Nb/Cu and Ta/Mo is given. Optical interferometry, X ray diffraction, and ion beam analysis techniques independently confirm that control of + and -0.3% is achieved over the amount of material deposited in each layer. Results of a study of Josephson tunneling to Nb/Cu metallic superlattices are reviewed. These measurements enable a determination of the London penetration depth to be made as a function of superlattice layer thickness. DOE

**N87-30198#** Massachusetts Inst. of Tech., Cambridge. Dept. of Materials Science and Engineering.
**DISLOCATION STRUCTURE AND ENERGY OF HIGH ANGLE (001) TWIST BOUNDARIES: A COMPUTER SIMULATION STUDY**
D. Schwartz, P. D. Bristowe, and V. Vitek Jun. 1987 42 p Prepared in cooperation with Pennsylvania Univ., Philadelphia
(Contracts DE-FG02-84ER-45116; DE-FG02-87ER-45310)
(DE87-012745; DOE/ER-45310/1) Avail: NTIS HC A03

High angle (001) twist boundaries have been investigated experimentally and the presence of grain boundary dislocations (GBD's) and associated cusps in the dependence of the boundary energy on misorientation, is in this case well established. However, in previous computer simulations neither localized GBD's nor distinct energy cusps have been identified. The aim of this study is to clarify this discrepancy between observations and computer modelling. For this purpose the structure and energy of a number of long period (high Sigma) twist boundaries with misorientations very close to Sigma - 5 have been calculated using empirical pair and n-body potentials to describe interatomic forces. Furthermore, an isolated GBD embedded into a Sigma - 5 boundary has been modeled. Well-defined cusps at Sigma - 5 misorientation and localized GBD's have been found but the reference Sigma - 5 structure is always the lowest energy structure which, in general, does not possess the symmetry of the coincidence site lattice. The misorientation dependence of the boundary energy is then discussed using coincidence site lattice. The misorientation dependence of the boundary energy is then discussed using a Read-Shockley type model. The cusps are always very shallow and may have an unconventional shape which is related to the dependence of the elastic energy on misorientation that is not

the same for twist and tilt boundaries, contrary to what is usually assumed. Finally, some remaining discrepancies between observed types of GBD's and those found in the present study are discussed in the light of the previously proposed multiplicities of boundary structures. DOE

**N87-30199#** Fraunhofer-Inst. fuer Festkoerpertechnologie, Munich (West Germany).
**LASER CRYSTALLIZATION OF POLYCRYSTALLINE SILICON LAYERS ON ISOLATING SUBSTRATES Final Report, Nov. 1984**
Heiner Ryssel, Josef Goetzlich, Reinhold Buchner, Qiu-xia Xu, Martin Peisl, Martin Bleier, and Gaby Henghuber Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 98 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-86-128; ISSN-0340-7608; ETN-87-90334) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 20.50

Active electronic devices in crystallized polysilicon layers on insulating substrates were realized. The suitability of various lasers, layer structures, and crystallization processes, as well as the electrical characteristics of the crystallized silicon layers were examined. It is shown that only CW lasers are suitable for the production of single crystal or large-area crystalline material. Crystal sizes up to 20x30 sq micron and crystallites of over 100 micron long were produced. Patterned substrates do not bring significant advantages due to the increased processing complexity. Substrate seeding methods allow the realization of selectively located monocrystalline areas. Crystallized-layer MOS transistors show operating characteristics approaching those of transistors in monocrystalline substrate. Seeded-layer transistors show identical results to those in reference material. Therefore these layers are suitable for the production of integrated circuits. ESA

**N87-30200#** Telefunken Electronic G.m.b.H., Heilbronn (West Germany).
**OPTIMIZATION OF THE PROPERTIES OF III-V SUBSTRATE MATERIALS Final Report, Dec. 1985**
Harald Matthes, Alexander Colquhoun, and Axel Heime Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 108 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie
(BMFT-FB-T-86-135; ISSN-0340-7608; ETN-87-90335) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 22.50

The optimization of the properties of substrate material for the fabrication of optoelectronic emitters and MESFET's made of III-V compounds was investigated. The substrate material properties affect the electrical characteristics of the components substantially. Substrate materials for the fabrication of GaAs:Si infrared emitting diodes, (wavelength 940 nm), (Ga Al)As:Si (wavelength 870 nm), LED's (wavelength 560 nm), and GaAs MESFET's were developed. ESA

**N87-30201#** Max-Planck-Inst. fuer Festkoerperforschung, Stuttgart (West Germany).
**SILICON EPITAXIAL LAYERS WITH SOLUTION TRANSPORT BY CENTRIFUGAL FORCES, AND THEIR STRUCTURAL AND ELECTRICAL CHARACTERIZATION BY ELECTRON MICROSCOPY METHODS Final Report, Dec. 1985**
Elisabeth Bauser and Horst Strunk Bonn, West Germany Bundesministerium fuer Forschung und Technologie Dec. 1986 102 p Partly in ENGLISH and GERMAN Sponsored by Bundesministerium fuer Forschung und Technologie, West Germany
(BMFT-FB-T-86-142; ISSN-0340-7608; ETN-87-90336) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 21.50

The liquid phase epitaxy of silicon for the growth of thin, differently doped silicon layers and layer packages was optimized. Thin silicon single and multilayers were grown epitaxially from solution by the centrifugal technique. The epitaxial system was fully automated and completed by a loading chamber. Thin monocrystalline Si-layers can be obtained on SiO2 by seeded lateral overgrowth in a higher crystalline quality than obtained with other techniques. The layer structures are found to be defect-free. The solvents used are Ga, In, Sn, Sb, and Bi, occasionally with As and P added as dopants. Quality checks show that defect-free layer and npnp multilayers of silicon can be manufactured reproducibly in a wide range of thickness and dopant concentration. The growth of Si on SiO2 is of particular interest for applications in three-dimensional integration. ESA

**N87-30202#** Stanford Univ., Calif. Center for Materials Research.
**RESEARCH AND CRYSTAL GROWTH ON HIGH DIELECTRIC CONSTANT MATERIALS FOR MILLIMETER WAVE APPLICATIONS Final Report, 1 Mar. 1982 - 30 Sep. 1986**
Robert S. Feigelson 5 Jun. 1987 61 p
(Contract N00014-82-K-0266)
(AD-A182960; CMR-87-2) Avail: NTIS HC A04/MF A01 CSCL 20B

The primary objective of this program was the growth of high quality single crystals for evaluation as potential candidates for electro-optic phase shifters in millimeter-wave applications. The research program was initially conceived as two parallel efforts. The first involved the application of new crystal growth techniques to the growth of strontium-barium titanate solid solutions. These materials are promising for the above applications but have been difficult to grow in the form of high quality single crystals. The second part of this program involved a study of some newly discovered ferroelectric materials; the ternary heavy metal fluorides and the niobates and tantalates of scandium. During the first year, it was decided that this latter effort should become the main focus of the program. GRA

**N87-30203#** Wisconsin Univ., Madison. Dept. of Chemistry.
**PHOTOLUMINESCENT PROPERTIES OF p-GaAs ELECTRODES RELATED TO THE PHOTOCURRENT ANOMALY: DETERMINATION OF SURFACE ELECTRON-CAPTURE VELOCITIES AND DEPLETION WIDTHS IN PHOTOELECTROCHEMICAL CELLS**
Phelps B. Johnson, Christopher S. McMillan, Arthur B. Ellis, and William S. Hobson 8 Jul. 1987 28 p
(Contract N00014-85-K-0631)
(AD-A182963; UWIS/DC/TR-87/4) Avail: NTIS HC A03/MF A01 CSCL 09E

Steady-state photoluminescence (PL) measurements have been used to determine depletion widths W and surface electron-capture velocities S for p-GaAs electrodes in aqueous acidic electrolytes. Electrodes subjected to slow cycling of applied potential (10 mV/s) exhibit a hysteresis in PL intensity in the photocurrent anomaly (PA) potential regime, characterized by negligible photocurrent at voltages up to approx. 0.5 V negative of the flatband potential (approx 0.1 V vs. SCE). A marked hysteresis in S values is observed in the PA potential regime of -0.1 to -0.4 V vs. SCE. Estimated S values are high, approaching 10 to the 7th power cm/s, but decrease significantly during anodic-going scans. Variations in W between -0.1 and -0.8 V vs. SCE indicate that strong Fermi-level pinning does not obtain. Electrode operation under a pulsed potential program (-0.05 to -1.00 V vs. SCE) caused a transient reduction in S of approximately an order of magnitude. GRA

**N87-30204#** Aerospace Corp., El Segundo, Calif. Electronics Research Lab.
**THE EFFECT OF OMCVD (ORGANOMETALLIC CHEMICAL VAPOR DEPOSITION) REACTOR RENOVATIONS ON GaAs EPILAYER GROWTH**
Donna M. Speckman and Jerry P. Wendt 20 Jul. 1987 21 p
(Contract F04701-85-C-0086)
(AD-A183020; TR-0086A(2925-01)-2; SD-TR-87-30) Avail: NTIS HC A02/MF A01 CSCL 20B

A major redesign and rebuilding of The Aerospace Corporation's Organometallic Chemical Vapor Deposition (OMCVD) reactor has been carried out. The entire gas-handling system was redesigned and replaced in order to reduce gas contamination, and new high-precision mass flow controllers and temperature baths were installed. Carrier gas flow through the organometallic bubblers was modified for improved safety and reliability, and gas lines that allow for the utilization of several different organometallic gallium and arsenic sources were also installed. Gallium arsenide (GaAs) epilayers grown using trimethylgallium (Me3Ga) and arsine (AsH3) in this reactor system following its renovation have consistently exhibited purity levels that are significantly higher than those of epilayers previously grown at The Aerospace Corporation. Epitaxial GaAs films (-4 microm thick) with excellent surface morphologies have been obtained which exhibit carrier concentrations of 3 x 10 14/cm to the 3rd power and 77 K mobilities of approximately 68,000 sq. cm/V-s. These physical and electrical characteristics are representative of state-of-the-art unintentionally doped GaAs. GRA

**N87-30205#** IBM Watson Research Center, Yorktown Heights, N.Y.
**CHEMISORPTION AND REACTIONS OF MOLECULES ON SEMICONDUCTOR SURFACES Final Technical Report, 1 Apr. 1977 - 31 Mar. 1985**
J. E. Demuth 18 May 1987 11 p
(Contract N00014-77-C-0366)
(AD-A183059) Avail: NTIS HC A02/MF A01 CSCL 07D

Experimental measurements have been performed of adsorbed atoms and molecules on metal and semiconductor surfaces over a wide range of temperatures (20K - 100K) to identify the nature of bonding, the structure, reaction intermediates and reaction products. This has included simple hydrocarbon and organic molecules on Ni, Pd, Pt and Ag single-crystal surfaces. The techniques of UV photoemission, low energy electron diffraction and high resolution electron energy loss spectroscopy were used and further developed to extract new information. The electronically excited states of absorbates relevant to Surface Enhanced Raman and Surface Chemistry were also investigated. Later work on Si(111) surfaces included studies of oxidation, water adsorption and metallization. GRA

**N87-30206#** Illinois Univ., Urbana. Engineering Research Center for Compound Semiconductor Microelectronics.
**AMPHOTERIC IMPURITIES IN GALLIUM ARSENIDE Final Report, 1 Nov. 1982 - 31 Jul. 1986**
Gregory E. Stillman 22 Jun. 1987 172 p
(Grant AF-AFOSR-0030-83)
(AD-A183119; AFOSR-87-0915TR) Avail: NTIS HC A08/MF A01 CSCL 20L

Gallium arsenide is already an important material for application in high frequency, low noise field effects transistors (FETs) and in optoelectronic devices, and future Gallium Arsenide (GaAs) high speed integrated circuits are expected to have a major impact on sophisticated high data rate electronic systems. In spite of the great effort that has been expended in developing high purity epitaxial and undoped semi insulating bulk material it has only recently been possible to identify the residual donors and acceptors present in high purity GaAs, and there are still several unanswered questions regarding these identifications. There was much speculation on the identification and source of the residual impurities in earlier work, but because of the lack of positive identification of the donor and acceptor species, and in some cases even the incorrect identification of the donor or acceptor species present, much of this early work is of little value. GRA

**N87-30207#** Stanford Univ., Calif.
**A WORKSHOP ON 3-5 SEMICONDUCTOR: METAL INTERFACIAL CHEMISTRY AND ITS EFFECT ON ELECTRICAL PROPERTIES, NOVEMBER 3-5, 1986**
William E. Spicer and Larry Cooper 5 Nov. 1986 659 p Workshop held 3-5 Nov. 1986
(Contract N00014-87-G-0038)
(AD-A183158) Avail: NTIS HC A99/MF A01 CSCL 20L

This workshop discusses: The Thermodynamics of Bulk Metal: 3-5 Systems Related to Interfacial Chemistry; Thermodynamic Considerations of Metal-GaAs Reactions plus TEM Results; Chemistry of Ti: GaAs Interfaces; Questions Concerning Interfacial Chemistry, Equilibrium, and Electrical Properties; The Chemistry and Morphology of Metal/3-5 Semiconductor Interfaces; Schottky Barriers on InP(110); Comparison to GaAs(110) Interface; Stable Phases at Reactive Metal/Compound Semiconductor Interfaces; Thermally Stable Ohmic Contact to n-type GaAs; Effects in Ohmic Contacts; Non Alloyed Ohmic Contacts by Solid State Reactions; Large Variations of GaAs Schottky Barrier Height by Interface Layers; Effects on Schottky Barriers of Metal Substitution in Semiconductors; 3-5 Interfaces: Schottky Barriers vs. Heterojunctions; A Comparison between Conventional and in-situ UHV Processing for Ge/GaAs and Co/GaAs Structures; Electrical Study of Schottky Barriers on Atomically Clean 3-5(110) Surfaces; A Comparison to the Results of Studies Using Surface Sensitive Techniques and Au-GaAs Ohmic Contacts; The Structure of Au/GaAs and Al/GaAs Interfaces; Refractory Silicide Contacts for Self-Aligned GaAs MESFETS; Heterojunction Growth and Impurity Incorporation During Vapor Growth of Compound Semiconductors; Reflection EXAFS Studies of Semiconductor-Metal Interfaces. GRA

**N87-30208#** State Univ. of New York, Buffalo. Dept. of Electrical and Computer Engineering.
**PHONON SHIFTS AND STRAINS IN STRAIN-LAYERED (Ga1-xInx)As Technical Report No. 8, 1 Aug. 1986 - 31 Jul. 1987**
Gerald Burns, Chu-Ryang Wie, Frank H. Dacol, G. D. Petit, and J. M. Woodall (IBM Research Lab., Yorktown Heights, N. Y.) 31 Jul. 1987 11 p
(Contract N00014-86-K-0622; Grant NSF ECS-87-07111)
(AD-A183320) Avail: NTIS HC A02/MF A01 CSCL 20L

The phonon frequencies (Raman Technique) and the strains (X-ray rocking curve technique) in (Ga1-xInx)As films is measured on GaAs (100) substrates. Films with various x-values and various thicknesses were studied. The films range from perfect epitaxial ones to those that have relaxed by different amounts. Using both of these measurements, all of the films give internal agreement, which indicates that the Raman technique can be used for in situ monitoring of the growth process. GRA

**N87-30209#** EIC, Inc., Norwood, Mass.
**SCHOTTKY BARRIER PHOTOELECTRODES WITH A VARIABLE BARRIER HEIGHT Final Report, 1 Oct. 1984 - 31 Mar. 1987**
R. D. Rauh, Timothy L. Rose, Thomas J. Lewis, M. M. Carrabba, and Stephen N. Benoit Aug. 1987 7 p
(Contract N00014-84-C-0758)
(AD-A183965) Avail: NTIS HC A02/MF A01 CSCL 20L

This program has dealt with characterizing junctions formed between semiconductors and insertion compounds. Examples of the latter are HxWO3 and HxIrO2, which have a variable work function according to the stoichiometry parameter, x. Specific applications of the structures to optically activated light modulators and to chemical sensors have been demonstrated. GRA

# 77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

No abstracts in this category.

# 80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

No abstracts in this category.

# 81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

**N87-30210*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**PROGRAM RISK ANALYSIS HANDBOOK**
R. G. Batson Aug. 1987 85 p
(NASA-TM-100311; NAS 1.15:100311) Avail: NTIS HC A05/MF A01 CSCL 05A

NASA regulations specify that formal risk analysis be performed on a program at each of several milestones. Program risk analysis is discussed as a systems analysis approach, an iterative process (identification, assessment, management), and a collection of techniques. These techniques, which range from extremely simple to complex network-based simulation, are described in this handbook in order to provide both analyst and manager with a guide for selection of the most appropriate technique. All program risk assessment techniques are shown to be based on elicitation and encoding of subjective probability estimates from the various area experts on a program. Techniques to encode the five most common distribution types are given. Then, a total of twelve distinct approaches to risk assessment are given. Steps involved, good and bad points, time involved, and degree of computer support needed are listed. Why risk analysis should be used by all NASA program managers is discussed. Tools available at NASA-MSFC are identified, along with commercially available software. Bibliography (150 entries) and a program risk analysis check-list are provided. Author

# 82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

**N87-30211#** Brookhaven National Lab., Upton, N. Y.
**DATA INTEGRATION FOR A SCIENTIFIC FIELD EXPERIMENT**
C. M. Benkovitz May 1987 10 p Presented at the Piecing the Puzzle Together Conference on Integrating Data for Decisionmaking, Washington, D.C., 27 May 1987
(Contract DE-AC02-76CH-00016)
(DE87-011302; BNL-39865; CONF-8705147-1) Avail: NTIS HC A02/MF A01

The Atmospheric Sciences Division at Brookhaven National Laboratory supports several projects involved in the development and application of data management techniques to compile, analyze and distribute scientific data sets that are the result of various multi-institutional experiments and data gathering projects. This paper will describe the data coordination function needed for one such experiment, the Cross Appalachian Tracer Experiment, which took place in September of 1983. The data needed for experiment planning had to be obtained and analyzed; the data produced during the field period by experiment participants had to be integrated with additional data sets produced outside of CAPTEX so that post experiment analyses could be conducted. Problems presented by the integration of diverse data sets flowing from multiple sources can be divided into problems requiring proper people interfacing and problems that can be solved via the use of computerized techniques. The degree of data integration given each CAPTEX data set was governed by its ultimate use and by the share of total resources available for the task. In this paper the solutions adopted for different data sets for both types of problems will be described. The resulting data sets are available to the scientific community at large. DOE

**N87-30212#** Cornell Univ., Ithaca, N.Y. Dept. of Computer Science.
**ISIS DOCUMENTATION, RELEASE 1**
Kenneth P. Birman, Thomas A. Joseph, and Frank Schmuck Jul. 1987 93 p
(Contract N00140-87-C-8904; Grant NSF DCR-82-12582)
(AD-A183149; CU-CSD-TR-87-849) Avail: NTIS HC A05/MF A01 CSCL 05B

Following are the partial contents of this ISIS documentation report: Addressing - how processes are addressed in ISIS; Authen - a tool used by process to protect against unauthorized requests; Config - configuration data structure manager; Compile - how to compile ISIS client programs under UNIX; Files - files the system uses, and how to start the system up; Filter - technical discussion of message filters, not for novices; Messgaes - all you need to know about messages in ISIS; Protection - overview protection features in ISIS; Replication - general purpose replicated data management tool; Startup - on starting up an ISIS program; and Transactions - a transaction facility. GRA

**N87-30213#** George Mason Univ., Fairfax, Va.
**REPRESENTATION OF INFORMATION IN SOFTWARE AND DATA BASES Final Report, 14 Jan. 1985 - 30 Jun. 1987**
Deborah A. Boehm-Davis, Robert W. Holt, and Matthew Koll 30 Jun. 1987 23 p
(Contract N00014-85-K-0243; RR0-4209)
(AD-A183181; TR-GMU-87-P01) Avail: NTIS HC A02/MF A01 CSCL 05B

A research program that examined the ways in which information can be represented in software and data bases is described. In the software production arena, structure was imposed on programs through the application of program design methodologies in the design phase. Modification performance and mental models formed during the experiment were examined as a function of design methodology for student and professional programmers. The data suggested that program structure had a much stronger influence on the student programmers. Further, the data showed that where program design led to different mental models, it also led to differences in modification performance. In the data base arena, the focus of the research was on the impact of structuring the information contained in the data base on the retrievability of information from that data base. Most existing data bases are organized around one of three data structures: hierarchical, network and relational. Each of these formats imposes certain restrictions on the way in which information is represented and on the way in which a user can add to, retrive, or change the information contained in the data base. The hypothesis is successfully tested that the process of retrieving information from a data base is aided by tailoring the format of the information in the data base to the format of the information to be retrieved. The data also suggest the important role that the underlying cognitive representation plays in determining performance. GRA

**N87-30214#** Naval Postgraduate School, Monterey, Calif.
**ACCESSING A FUNCTIONAL DATABASE VIA CODASYL-DML TRANSACTIONS M.S. Thesis**
Harry Coker, Jr. Jun. 1987 74 p
(AD-A183202) Avail: NTIS HC A04/MF A01 CSCL 05B

Conventional approaches to the design and implementation of database systems have been upon the premise of a single data model with its model-based data language, thus restricting the database system to transactions based solely on a specific model and written in a specific data language. This traditional approach has drastically hindered the widespread interaction of database systems based on various data models and languages. As an

alternative to this traditional and less effective approach to database systems, the multi-lingual database system (MLDS) has evolved. MLDS has allowed via their corresponding data language. This thesis implements a methodology for accessing and manipulating databases stored in a particular data model via transactions of a separate data model; specifically, a functional database is accessed via CODASYL-DML transactions. This interface is the initial move toward extending MLDS to a thoroughly Multi-Model Database System (MMDS). GRA

**N87-30215#** Army Concepts Analysis Agency, Bethesda, Md.
**MICROCOMPUTER INTEGRATED LIBRARY SYSTEM (MILS). THE ONLINE INTEGRATED TECHNICAL INFORMATION CENTER SYSTEM AT US ARMY CONCEPTS ANALYSIS AGENCY (CAA) Final Report**
Lynda S. Kuntz Sep. 1986 146 p
(AD-A183238; CAA-TP-86-10) Avail: NTIS HC A07/MF A01 CSCL 05B

This technical paper presents the analysis of a system for the storage and retrieval of books and documents at the US Army Concepts Analysis Agency (CAA). It includes both the classified and unclassified technical information centers. The analysis indicated that a Microcomputer Integrated Library System (MILS) was appropriate for the organization, management , and retrieval of the Agency's book and document collection. Cataloging information from OCLC and DTIC is used to create data bases in dBase III. MILS consists of the following modules: online catalog, acquisition/cataloging, circulation, serials control and management. The online catalog provides access by author, title, subject, series statement, DTIC AD number, organization, publisher, and report number. Boolean logic is available in the title and subject searching. In addition to dBase III software, the system requires Wordstar or another spellcheck program, and FORTRAN 77 Compiler. The hardware requirements are an IBM with hard disk (or compatible), Modem, tapedeck unit, and printer. The dBase III programs are included in the appendices. GRA

**N87-30216#** Harvard Univ., Cambridge, Mass. Dept. of Psychology.
**UNDERSTANDING CHARTS AND GRAPHS Technical Report, 1 Apr. 1985 - 31 Jul. 1987**
Stephen M. Kosslyn 28 Jul. 1987 90 p
(Contract N00014-85-K-0291; RR0-4204)
(AD-A183409; TR-8) Avail: NTIS HC A05/MF A01 CSCL 05B

Many charts and graphs do not convey information effectively. This paper develops a way of analyzing the information in charts and graphs that reveals the design flaws in the display. The analytic scheme requires isolating four types of constituents in a display, and specifying their structure and interrelations at a syntactic, semantic, and pragmatic level of analysis. As the description is constructed, one checks for violations of acceptability principles, which are derived from facts about human visual information processing and from an analysis of the nature of symbols. Violations of these principles reveal the source of potential difficulties in using a display. GRA

**N87-30217#** Spectra Research Systems, Inc., Huntsville, Ala. Systems Technology Div.
**CREATION OF A DATA BASE ON ENERGETIC MATERIALS Final Report, 18 Sep. 1986 - 16 Mar. 1987**
Phil M. Johnson, Rodney S. Myers, Bruce K. Tiller, and Charles Ribaudo 10 Aug. 1987 55 p
(Contract DAAA21-86-C-0288)
(AD-A183456; SRS/STD-TR87-44/6600; ARAED-CR-87011)
Avail: NTIS HC A04/MF A01 CSCL 05B

A survey of over 1,900 energetic materials specialists in both government and industry was conducted to determine the feasibility of establishing an energetic materials data base. The results indicated that most users want a user-friendly system that incorporates on-line help and software menus, as well as a sophisticated query language to handle complex searches. A substantial list of material properties and characteristics was obtained from the survey as well. Based on these requirements, an extensive software selection study was conducted to find the best candidate Data Base Management System (DBMS) for the Energetic Materials Data Base (EMDB). Only relational type DBMS's were considered because of the need for a highly flexible data base structure. Forty packages were evaluated based on fixed criteria which resulted in several demonstrations and the identification of three major candidate systems. GRA

**N87-30218*#** National Aeronautics and Space Administration, Washington, D.C.
**NASA SCIENTIFIC AND TECHNICAL PUBLICATIONS: A CATALOG OF SPECIAL PUBLICATIONS, REFERENCE PUBLICATIONS, CONFERENCE PUBLICATIONS, AND TECHNICAL PAPERS, 1977-1986**
Sep. 1987 390 p
(NASA-SP-7063; NAS 1.21:7063) Avail: NTIS HC free as PR-655B; NASA Scientific and Technical Information Facility, P.O. Box 8757, BWI Airport, Md. 21240 HC free CSCL 05B

This catalog lists 2311 citations of all NASA Special Publications, NASA Reference Publications, NASA Conference Publications, and NASA Technical Papers that were entered into the NASA scientific and technical database during the decade 1977 through 1986. The entries are grouped by subject category. Indexes of subject terms, personal authors, and NASA report numbers are provided. Author

**N87-29511#** International Business Machines Corp., Gaithersburg, Md.
**STARS, POLYGONS AND CLUSTERS**
Robert O. Turek and Joel S. Greenstein (Clemson Univ., S.C.) *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 7 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29512#** Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio. Human Engineering Div.
**AN ASSESSMENT OF VARIABLE FORMAT INFORMATION PRESENTATION**
J. A. Forester *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 13 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29513#** Naval Aerospace Medical Research Lab., Pensacola, Fla.
**PERCEPTUAL PROCESSING CAPABILITIES RELEVANT TO DESIGN OF VISUAL DISPLAYS FOR INFORMATION MANAGEMENT IN ADVANCED AIRBORNE WEAPON SYSTEMS**
Tommy R. Morrison *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 9 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29514#** Royal Air Force Inst. of Aviation Medicine, Farnborough (England).
**PERCEPTUAL ORGANISATION AND INFORMATION MANAGEMENT**
R. M. Taylor *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 28 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29515#** Royal Aircraft Establishment, Farnborough (England). Flight Systems Dept.
**INFORMATION MANAGEMENT IN THE ARMY BATTLEFIELD HELICOPTER**
C. P. Gibson and D. Williams *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 13 p (For primary document see N87-29503 24-06)

see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

**N87-29517#** Mitre Corp., Bedford, Mass.
**ADVANCED INFORMATION MANAGEMENT AND DECISION MAKING IN AIRBORNE EARLY WARNING AND CONTROL (AEW&C) TRAINING SYSTEMS**
L. M. Rosa, E. L. Estochen, J. L. Bottomley, and M. J. Hebert *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems Feb. 1987 12 p (For primary document see N87-29503 24-06)
Copyright Avail: NTIS HC A14/MF A01

# 83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

No abstracts in this category.

# 84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

**N87-30219#** Committee on Appropriations (U.S. Senate).
**DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT - INDEPENDENT AGENCIES APPROPRIATION BILL, 1988**
William Proxmire Washington GPO 6 Oct. 1987 117 p Report to accompany H.R. 2783 presented by the Committee on Appropriations, 100th Congr., 1st Sess., 6 Oct. 1987
(S-Rept-100-192) Avail: NTIS HC A06/MF A01

Budget authority for the Department of Housing and Urban Development, the Veterans Administration, the National Aeronautics and Space Administration, the Environmental Protection Agency, The National Science Foundation, and other agencies, commissions, boards, corporations, institutes, and offices is discussed. For individual titles, see N87-30220 through N87-30220.

**N87-30220#** Committee on Appropriations (U.S. Senate).
**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**
*In its* Department of Housing and Urban Development - Independent Agencies Appropriation Bill, 1988 6 Oct. 1987 p 64-73 (For primary document see N87-30219 24-84)
Avail: NTIS HC A06/MF A01

The objectives of the NASA program of research and development are to extend the knowledge of the Earth, its space environment, and the universe; to expand the practical applications of space technology; to develop, operate, and improve unmanned space vehicles; to provide technology for improving the performance of aeronautical vehicles while minimizing the environmental effects and energy consumption; and to assure continued development of the aeronautics and space technology necessary to accomplish national goals. The appropriations necessary to accomplish these goals are examined. B.G.

**N87-30221#** Committee on Commerce, Science, and Transportation (U.S. Senate).
**NASA AUTHORIZATION: AUTHORIZATION OF APPROPRIATIONS FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION FOR FISCAL YEAR 1988**
Washington GPO 1987 471 p Hearings on S-Hrg-100-231 before the Subcommittee on Science, Technology and Space of the Committee on Commerce, Science and Transportation, 100th Congress, 1st Session, 3, 19, 26 Feb.; 5 Mar. and 29 Apr. 1987
(GPO-73-245) Avail: NTIS HC A20/MF A01

Appropriations for the FY88 budget for NASA are examined. Prioritization of the four upcoming planetary missions-Galileo, Ulysses, Magellan, and the Mars Observer is discussed. Obstacles which delay the return of the shuttles to service and which delay the building of the space station are also discussed. B.G.

# 85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

**N87-30222#** Department of Energy, Washington, D. C.
**THE 8TH INTERNATIONAL ELECTRIC VEHICLE SYMPOSIUM**
1986 539 p Symposium held in Washington, D.C., 20 Oct. 1986 Prepared in cooperation with Edison Electric Inst., New York and Electric Power Research Inst., Palo Alto, Calif.
(DE87-010697; CONF-8610122) Avail: NTIS HC A23/MF A01

The proceedings from the symposium are presented. Major topics discussed include: battery technology, powertrains; hybrid vehicles, marketing and economics, propulsion, and electric vehicle design and performance. Each paper has been separately indexed for inclusion in the Energy Data Base. DOE

**N87-30223*#** Mechanical Technology, Inc., Latham, N. Y. Engine Systems Div.
**AUTOMOTIVE STIRLING ENGINE DEVELOPMENT PROGRAM Semiannual Technical Progress Report, 1 Jul. - 31 Dec. 1984**
N. Nightingale, A. Richey, R. Farrell, G. Riecke, W. Ernst, R. Howarth, M. Cronin, M. Simetkosky, G. Smith, and J. Meacher Nov. 1985 87 p
(Contracts DEN3-32; DE-AI01-85CE-50112)
(NASA-CR-174873; DOE/NASA/0032-25; DOE/NASA/0032-80/7; NAS 1.26:174873; MTI-85ASE445SA7) Avail: NTIS HC A05/MF A01 CSCL 13F

Development test activities on Mod I engines directed toward evaluating technologies for potential inclusion in the Mod II engine are summarized. Activities covered include: test of a 12-tube combustion gas recirculation combustor; manufacture and flow-distribution test of a two-manifold annular heater head; piston rod/piston base joint; single-solid piston rings; and a digital air/fuel concept. Also summarized are results of a formal assessment of candidate technologies for the Mod II engine, and preliminary design work for the Mod II. The overall program philosophy weight is outlined, and data and test results are presented. Author

**N87-30224#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
**AIR FORCE TECHNICAL OBJECTIVE DOCUMENT FISCAL YEAR 1988**
Alan M. Salus and Robert L. Denison Dec. 1986 81 p Supersedes AFWAL-TR-85-4000, AD-A167324
(AD-A183017; AFWAL-TR-86-4000; AFWAL-TR-85-4000) Avail: NTIS HC A05/MF A01 CSCL 11D

This Technical Objective Document was prepared by the A.F. Materials Laboratory and describes the technical program in materials to meet future Air Force operational needs. The technology program is divided into ten Focal Areas which encompass the full spectrum of materials capabilities required for future aircraft, missile, space and electronic systems. These ten areas are: Thermal Protection Materials and Structures; Metallic Structural Materials; Nonmetallic Structural Materials; Nondestructive Evaluation; Aerospace Propulsion Materials; Nonstructural Materials: Electromagnetic Windows and Electronic Materials; Laser Hardened Materials; Computer Aided Manufacturing/Manufacturing R and D; and Systems Support. GRA

**N87-30225*#** Garrett Turbine Engine Co., Phoenix, Ariz.
**ADVANCED GAS TURBINE (AGT) TECHNOLOGY DEVELOPMENT PROJECT Annual Interim Report, 1 Jul. 1985 - 30 Jun. 1986**
Feb. 1987 132 p
(Contract DEN3-167)
(NASA-CR-180818; DOE/NASA/0167-11; NAS 1.26:180818; GARRETT-31-3725(11)) Avail: NTIS HC A07/MF A01 CSCL 13F

This report is the eleventh in the series of Technical Summary reports for the Advanced Gas Turbine (AGT) Technology Development Project, authorized under NASA Contract DEN3-167, and sponsored by the Department of Energy (DOE). This report was prepared by Garrett Turbine Engine Company, A Division of the Garrett Corporation, and includes information provided by Ford Motor Company, the Standard Oil Company, and AiResearch Casting Company. This report covers plans and progress for the period July 1, 1985 through June 30, 1986. Technical progress during the reported period was highlighted by the 85-hour endurance run of an all-ceramic engine operating in the 2000 to 2250 F temperature regime. Component development continued in the areas of the combustion/fuel injection system, regenerator and seals system, and ceramic turbine rotor attachment design. Component rig testing saw further refinements. Ceramic materials showed continued improvements in required properties for gas turbine applications; however, continued development is needed before performance and reliability goals can be set. Author

# 88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

# 89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

**N87-30226** Deutsche Geodaetische Kommission, Munich (West Germany).
**A CONTRIBUTION TO THE CALCULATION OF EPHEMERIDES AND TO PARAMETER ESTIMATION IN THE EARTH-MOON SYSTEM Ph.D. Thesis - Techische Univ., Munich, West Germany [EIN BEITRAG ZUR EPHEMERIDENRECHNUNG UND PARAMETERSCHAETZUNG IM ERDE-MOND-SYSTEM]**
Heinrich Gleixner 1986 101 p In GERMAN Sponsored by Deutsches Forschungsgemeinschaft
(Ser-C-319; ISBN-3-7696-9369-8; ISSN-0065-5325; ETN-87-90357) Copyright Avail: Issuing Activity

The formulation of a consistent model of field and balance equations for the dynamics of the Earth-Moon system was studied, on the basis of the post-Newton approximation. The equations of motion for the translation and rotation of Moon and Earth are outlined. The motion components were simultaneously integrated. Modeling of the three motion components was stepwise refined, starting with a particle model, followed by the model of a dilatated body (a particle) and by the model of two dilatated bodies. The parameters of the Earth-Moon system were estimated by comparing lunar laser ranging data and approximated values from a model calculation. The results represent a first step towards a consistent model of the Earth-Moon dynamics. ESA

**N87-30227** Deutsche Geodaetische Kommission, Munich (West Germany).
**DESIGN OF A NONRELATIVISTIC GEODETIC-ASTRONOMICAL REFERENCE SYSTEM Ph.D. Thesis - Stuttgart Univ., West Germany [ENTWURF EINES NICHTRELATIVISTISCHEN GEODAETISCH-ASTRONOMISCHEN BEZUGSSYSTEMS]**
Burghard Richter 1986 158 p In GERMAN; ENGLISH summary
(Ser-C-322; ISBN-3-7696-9372-8; ISSN-0065-5325; ETN-87-90359) Copyright Avail: Issuing Activity

The functional model of geodetic astronomy was analyzed with regard to the usual hypotheses concerning known star coordinates, known Earth orientation, and the various commonly applied reductions. A systematic presentation of the traditional solution without reduction effects is given in the form of a commutative diagram of transformations between natural reference frames defined by a sequence of fundamental vectors, resulting in a basic equation of geodetic astronomy in matrix form. The effects of deformation of the Earth and its gravitational field on astronomical observations are discussed. A novel conception of reference frames is suggested, in which the traditional hierarchy based on a set of fundamental vectors is completely replaced by three conventional reference frames. The relative orientations of these three reference frames have to be described by three time-dependent parameters. ESA

**N87-29550#** Joint Publications Research Service, Arlington, Va.
**DETECTION OF CLOSE BINARY SYSTEMS BY OBSERVATIONS OF LUNAR OCCULTATIONS OF STARS USING 6-METER TELESCOPE Abstract Only**
G. M. Beskin, M. B. Bogdanov, S. I. Neizvestnyy, A. A. Pimonov, V. L. Plakhotnichenko, and V. F. Shvartsman *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 32 Transl. into ENGLISH from Astronomicheskiy Zhurnal (Moscow, USSR), v. 64, no. 1, Jan. - Feb. 1987 p 108-118 Original language document was announced in IAA as A87-34138 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29552#** Joint Publications Research Service, Arlington, Va.
**ASTRONOMIC REFRACTION IN POLAR REGIONS BASED ON AEROLOGIC SOUNDINGS Abstract Only**
F. D. Zablotskiy and L. A. Kulish *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 34 Transl. into ENGLISH from Geodeziya i Kartografiya (Moscow, USSR), no. 1, Jan. 1987 p 17-20 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

# 90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics.*

**N87-30228#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Dept. de Astrofisica.
**ENVIRONMENTAL EFFECTS ON SEYFERT GALAXIES**
S. D. Kirhakos and J. E. Steiner Apr. 1987 18 p Submitted for publication
(INPE-4145-PRE/1052) Avail: NTIS HC A02/MF A01

A statistical analysis of the environmental effects on Seyfert galaxies (SGs) is presented. Two samples are analyzed; the first comprises 282 SGs known until 1983 and the second is a subsample selected in an unbiased way. The distance of the Seyfert to its nearest galaxy was compared to the similar parameter of a control sample. It was also compared to an artificial sample obtained by numerical simulation. The main conclusions of the analysis are: (1) 40 percent of the SGs have a companion galaxy closer as compared to non-Seyfert galaxies; (2) low luminosity Seyfert nuclei seem to have companions more frequently than high luminosity ones; (3) extrapolating the results to quasars, it is predicted that about 25 percent of them should be triggered by galaxy collisions; (4) these results are interpreted in terms of the canonical model of accreting supermassive black holes in the nuclei of galaxies. It is proposed that tidal galaxy collisions enhance the accretion rate of the interstellar gas into the central black

hole; and (5) the tidal radius for triggering the Seyfert phenomenon is 400 kpc. Author

**N87-30229#** Los Alamos National Lab., N. Mex.
**PERIOD SPACINGS IN PG 1159-035 MODELS**
A. N. Cox 1987 4 p Presented at the IAU Colloquium 95, Tucson, Ariz., 1 Jun. 1987
(Contract W-7405-eng-36)
(DE87-011744; LA-UR-87-2132; CONF-8706143-1) Avail: NTIS HC A02/MF A01

The 8 periods of hot pre-white dwarf nonradial pulsator, PG 1159-035, has been used for stellar seismology to probe its internal structure. DOE

**N87-30230#** Arizona State Univ., Tempe. Dept. of Physics and Astronomy.
**NONRADIAL PULSATIONS OF HOT EVOLVED STARS**
S. G. Starrfield 1987 17 p Presented at the IAU Colloquium 95, Tucson, Ariz., 1 Jun. 1987 Prepared in cooperation with Los Alamos National Lab., N. Mex.
(Contract W-7405-eng-36)
(DE87-011773; LA-UR-87-2010; CONF-8706143-2) Avail: NTIS HC A02/MF A01

There are three classes of faint blue variable stars: the ZZ Ceti variables (DAV degenerate dwarfs), the DBV variables (DB degenerate dwarfs), and the GW Vir variables (DOV degenerate dwarfs). None of these was known at the time of the last blue star meeting. Observational and theoretical studies of the ZZ Ceti variables, the DBV variables, and the GW Vir variables have shown them to be pulsating in nonradial g-modes. The cause of the pulsation has been determined for each class of variable star and, in all cases, also involves predictions of the stars envelope composition. The predictions are that the ZZ Ceti variables must have pure hydrogen surface layers, the DBV stars must have pure helium surface layers, and the GW Vir stars must have carbon and oxygen rich surface layers with less than 30% (by mass) of helium. Given these compositions, it is found that pulsation driving occurs as a result of the kappa and gamma effects operating in the partial ionization zones of either hydrogen or helium. In addition, a new driving mechanism, called convection blocking, also occurs in these variables. For the GW Vir variables, it is the kappa and gamma effects in the partial ionization regions of Carbon and Oxygen blocking, also occurs in these variables. For the GW Vir variables, it is the kappa and gamma effects in the partial ionization regions of carbon and oxygen. DOE

**N87-30231#** California Univ., Berkeley. Lawrence Berkeley Lab.
**ROLE OF PIONS AND HYPERONS IN NEUTRON STARS AND SUPERNOVAE**
N. K. Glendenning May 1987 4 p Presented at the 11th International Conference on Particles and Nuclei, Kyoto, Japan, 20 Apr. 1987
(Contract DE-AC03-76SF-00098)
(DE87-012033; LBL-23373; CONF-870413-3) Avail: NTIS HC A02/MF A01

Neutron stars are studied in the framework of nuclear relativistic field theory. Hyperons and pions significantly soften the equation of state of neutron star matter at moderate and high density. We conjecture that they are responsible for the softening that is found to be crucial to the bounce scenario in supernova calculations. Hyperons reduce the limiting mass of neutron stars predicted by theory by one half solar mass or more, which is a large effect compared to the range in which theories of matter predict this limit to fall. DOE

**N87-30232*#** Louisiana State Univ., Baton Rouge. Dept. of Physics and Astronomy.
**ORIGIN AND TRANSPORT OF HIGH ENERGY PARTICLES IN THE GALAXY Final Technical Report, 1 Mar. 1984 - 28 Feb. 1987**
John P. Wefel 28 Feb. 1987 21 p
(Grant NAGw-550)
(NASA-CR-181368; NAS 1.26:181368) Avail: NTIS HC A02/MF A01 CSCL 03B

The origin, confinement, and transport of cosmic ray nuclei in the galaxy was studied. The work involves interpretations of the existing cosmic ray physics database derived from both balloon and satellite measurements, combined with an effort directed towards defining the next generation of instruments for the study of cosmic radiation. The shape and the energy dependence of the cosmic ray pathlength distribution in the galaxy was studied, demonstrating that the leaky box model is not a good representation of the detailed particle transport over the energy range covered by the database. Alternative confinement methods were investigated, analyzing the confinement lifetime in these models based upon the available data for radioactive secondary isotopes. The source abundances of several isotopes were studied using compiled nuclear physics data and the detailed transport calculations. The effects of distributed particle acceleration on the secondary to primary ratios were investigated. Author

**N87-30233#** Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
**INTERPLANETARY PROTON (0.61 LESS THAN ep LESS THAN 3.41 MeV) EVENTS OBSERVED WITH PIONEER 11, 1973-1986 AND OUT TO 22.4 AU Progress Report**
James A. VanAllen Jul. 1987 33 p
(Contract N00014-85-K-0404)
(AD-A182995; U-OF-IOWA-87-22) Avail: NTIS HC A03/MF A01 CSCL 03B

A survey of interplanetary proton (0.61 less than E sub p less than 3.41 MeV) events is summarized in graphical and tabular form for the period April 1973 through December 1986. The observations were obtained by an effectively continuous data stream from the spacecraft Pioneer 11 as it moved outwards in the solar system from 1.0 to 22.4 AU. Two hundred and sixty five distinct events are identified. The spectra and intensities of the protons, presumed to be originally of solar origin, are influenced dramatically by propagative and accelerative processes in the interplanetary medium. GRA

**N87-30234#** Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
**INTERPLANETARY PROTONS (E SUB p APPROX = 1 MeV) 1973-1986 AND OUT TO 22.4 AU Progress Report**
J. A. VanAllen Aug. 1987 23 p
(Contract N00014-85-K-0404)
(AD-A183842; U-OF-IOWA-87-26) Avail: NTIS HC A02/MF A01 CSCL 03B

This paper uses a homogeneous body of data on mean annual values N of the interplanetary intensity of protons (0.61 less than Ep less than 3.41 MeV) in the period 1973-1986 and over the heliocentric radial distance range 1.0 less than r less than 22.4 AU. It is found that the quantity N(r-sq) is well correlated with the annual mean sunspot number, with the exception of anomalously low values in 1979, 1980 (in particular), and 1981. The anomaly is attributed to a gross change in the interplanetary magnetic field associated with reversal of the polarity of the sun's polar field. GRA

**N87-30235*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**ATLAS OF COMET HALLEY 1910 II**
Bertram Donn, Juergen Rahe, and John C. Brandt 1986 597 p
(NASA-SP-488; NAS 1.21:488; LC-86-16341) Avail: SOD HC $48.00 as 033-000-00991-7; NTIS MF A01 CSCL 03B

With the impending return of Halley's Comet in 1986, a major effort began to collect the material obtained at its last appearance in 1910. This material displays the evolving coma and tail phenomena, and is useful for comparison with the present quantitative studies of spectroscopic and structural phenomena. Images in the atlas are arranged in chronological order by day. Days that have multiple images with varying scale are arranged in two sequences. Photographs showing tail phenomena are first, followed by photographs obtained with longer focus instruments

showing the head or near-nuclear region. Drawings of Comet Halley, made from visual observations in 1835 and 1910, also are included. B.G.

**N87-29549#** Joint Publications Research Service, Arlington, Va.
**OUTBURST FREQUENCY AND SPATIAL DISTRIBUTION OF TYPE 1 AND TYPE 2 SUPERNOVAE Abstract Only**
D. Yu. Tsvetkov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 31 Transl. into ENGLISH from Astronomicheskiy Zhurnal (Moscow, USSR), v. 64, no. 1, Jan. - Feb. 1987 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29571#** Joint Publications Research Service, Arlington, Va.
**THERMAL AND PHOTOMETRIC MODEL OF COMETARY NUCLEUS Abstract Only**
M. Ya. Marov, A. V. Kolesnichenko, and Yu. V. Skorov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 78 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 21, no. 1, Jan. - Mar. 1987 p 47-60 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29572#** Joint Publications Research Service, Arlington, Va.
**REFINEMENT OF COORDINATES OF HALLEY'S COMET WITH ALLOWANCE FOR DISPLACEMENT OF OPTICAL CENTER RELATIVE TO COMETARY CENTER OF MASS Abstract Only**
V. V. Savchenko *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 79 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 21, no. 1, Jan. - Mar. 1987 p 61-64 Original language document was announced in IAA as A87-42945 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

# 91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**N87-30236*#** Lunar and Planetary Inst., Houston, Tex.
**MECA WORKSOP ON DUST ON MARS 2**
Steven Lee, ed. Feb. 1986 80 p Workshop held at Tempe, Ariz., 24-26 Feb. 1986
(Contract NASw-4066)
(NASA-CR-180545; NAS 1.26:180545; LPI-TP-86-09) Avail: NTIS HC A05/MF A01 CSCL 03B

Topics addressed include: sedimentary debris; mineralogy; Martian dust cycles; Mariner 9 mission; Viking observations; Mars Observer; atmospheric circulation; aeolian features; aerosols; and landslides. B.G.

**N87-30237#** Los Alamos National Lab., N. Mex.
**FIRST POLYMER IN COMET HALLEY: POLYOXYMETHYLENE**
W. F. Huebner, D. C. Boice, and C. M. Sharp 1987 6 p Presented at the Conference on Similarities and Dissimilarities of Comets, Brussels, Belgium, 6 Apr. 1987 Prepared in cooperation with Southwest Research Inst., San Antonio, Tex.
(Contract W-7405-eng-36)
(DE87-010139; LA-UR-87-1793; CONF-8704138-1) Avail: NTIS HC A02/MF A01

The RPA2-Positive Ion Cluster Composition Analyzer (PICCA) on the Giotto spacecraft detected five mass peaks with regular spacing of about 15 amu up to about 120 amu. Starting at about 45 amu, the peaks decrease in intensity with increasing mass. Within their half-width they are in good agreement with dissociation products of formaldehyde polymer (POM). We suggest a production sequence in which cosmic radiation formed POM from water and carbon monoxide on grains that were aggregated into cometisimals. Other polymers, possibly containing CN, may also exist. Observations suggest that at least some of the H-, C-, and O-containing dust particles detected by the Particle Impact Analyzer (PIA) on board of the Giotto spacecraft and its equivalent (PUMA) on the Vega 1 and 2 spacecraft contain POM. The properties of POM are consistent with many of the unexpected observations in the coma. DOE

**N87-30238*#** San Jose State Univ., Calif. Mars Exobiology Research Consortium.
**THE SPECTROSCOPIC CHEMICAL AND PHOTOPHYSICAL PROPERTIES OF MARTIAN SOILS AND THEIR ANALOGS Progress Report, 1986/1987**
Lelia M. Coyne 19 Oct. 1987 73 p
(Contract NCC2-345)
(NASA-CR-181373; NAS 1.26:181373) Avail: NTIS HC A04/MF A01 CSCL 03B

The program of research outlined should advance significantly the understanding of the spectral signal of montmorillonites in general and the variations produced in it by structural and surface ferric and ferrous iron and interlayer water as a function of several environmental conditions that are different between Earth and Mars. In addition, an extensive data base was collected providing spectral characterization of several features (iron, both surface and structural, OH-groups, both structural and from adsorbed water and O(-) centers) that are known, or thought to be, influential in directing the surface activity of these important materials. With this data base with which to assess the results of the Viking labeled release simulation studies, it should be possible to gain important insights into the mechanisms of surface reactivity for this important chemical reaction. The results to be gained from these studies will provide a significant body of ground base truth from which to assess: the presence of smectite clays on Mars; the mineralogical form in which the Martian iron is bound; establish upper limits on the present surface water content of Martian soils; perhaps provide insights on the Martian surface radiation history; and to make strong predictions about the nature of surface chemistry on Mars, if iron-bearing clays are a significant component of the surface mineralogical assemblage. Author

**N87-30239*#** Arkansas Coll., Batesville. Dept. of Chemistry.
**DETERMINATION OF HYDROGEN ABUNDANCE IN SELECTED LUNAR SOILS Final Technical Report, 1 Jun. - 31 Oct. 1987**
Roberta Bustin 31 Oct. 1987 42 p
(Grant NAG9-222)
(NASA-CR-181408; NAS 1.26:181408) Avail: NTIS HC A03/MF A01 CSCL 03B

Hydrogen was implanted in lunar soil through solar wind activity. In order to determine the feasibility of utilizing this solar wind hydrogen, it is necessary to know not only hydrogen abundances in bulk soils from a variety of locations but also the distribution of hydrogen within a given soil. Hydrogen distribution in bulk soils, grain size separates, mineral types, and core samples was investigated. Hydrogen was found in all samples studied. The amount varied considerably, depending on soil maturity, mineral types present, grain size distribution, and depth. Hydrogen implantation is definitely a surface phenomenon. However, as constructional particles are formed, previously exposed surfaces become embedded within particles, causing an enrichment of hydrogen in these species. In view of possibly extracting the hydrogen for use on the lunar surface, it is encouraging to know that hydrogen is present to a considerable depth and not only in the upper few millimeters. Based on these preliminary studies, extraction of solar wind hydrogen from lunar soil appears feasible, particulary if some kind of grain size separation is possible. B.G.

**N87-29562#** Joint Publications Research Service, Arlington, Va.
**RESONANCE PHENOMENA ACCOMPANYING EVOLUTION OF TRANSLATIONAL-ROTATIONAL MOTION OF VISCOELASTIC PLANET Abstract Only**
V. G. Vilke and K. M. Lebedev *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 47 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 148-152 Original language

document was announced in IAA as A87-34222 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29568#** Joint Publications Research Service, Arlington, Va.
**CATALOGUE OF CRATERS IN VENUSIAN NORTHERN HEMISPHERE BEARING EVIDENCE OF IMPACT ORIGIN Abstract Only**
I. M. Chernaya, V. P. Kryuchkov, A. T. Bazilevskiy, G. A. Burba, O. N. Rzhiga, G. M. Petrov, A. I. Sidorenko, and Yu. P. Aleksandrov *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 75 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 21, no. 1, Jan. - Mar. 1987 p 26-36 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29569#** Joint Publications Research Service, Arlington, Va.
**COMPUTING GAMMA QUANTA FLUX DENSITIES OVER VENUSIAN AND EARTH'S SURFACES Abstract Only**
Yu. A. Surkov and O. S. Manvelyan *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 76 Transl. into ENGLISH from Astronomicheskiy Vestnik (Moscow, USSR), v. 21, no. 1, Jan. - Mar. 1987 p 37-46 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

# 92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

For related information see *93 Space Radiation.*

**N87-30240#** National Geophysical Data Center, Boulder, Colo.
**SOLAR-GEOPHYSICAL DATA NUMBER 512, APRIL 1987. PART 1: (PROMPT REPORTS). DATA FOR MARCH 1987, FEBRUARY 1987 AND LATE DATA**
Helen E. Coffey, ed. Apr. 1987 84 p
(Contract N00014-86-F-0049)
(PB87-195251; SGD-512-Pt-1; ISSN-0038-0911; LC-79-640375)
Avail: NTIS HC A05/MF A01 CSCL 03B

Included are the detailed index for 1986-1987; data for March 1987 (advance and worldwide IUWDS alert periods, solar activity indices, solar flares, solar radio emission, Vostok inferred interplanetary magnetic field polarity, and Stanford mean solar magnetic field); data for February 1987 (solar active regions, sudden ionospheric disturbances, solar radio spectral observations, cosmic ray measurements by neutron monitor, geomagnetic indices, and radio propagation indices); and late data (cosmic ray measurements by neutron monitor Tokyo October 1986-January 1987, geomagnetic indices January 1987, solar active regions, and geomagnetic indices January 1987). GRA

**N87-30241#** National Geophysical Data Center, Boulder, Colo.
**SOLAR-GEOPHYSICAL DATA NUMBER 512, APRIL 1987. PART 2: (COMPREHENSIVE REPORTS). DATA FOR OCTOBER 1986**
Helen E. Coffey, ed. Apr. 1987 50 p Sponsored by Office of Naval Research, Arlington, Va.
(PB87-195269; ISSN-0038-0911; LC-79-640375) Avail: NTIS HC A03/MF A01 CSCL 03B

Included are the detailed index for 1986-1987 and data for October 1986 (Meudon carte synoptique, solar flares, solar radio bursts at fixed frequencies, solar X-ray radiation from GOES satellite, mass ejections from the sun, and active prominences and filaments). GRA

**N87-30242#** National Center for Atmospheric Research, Boulder, Colo.
**WHITE LIGHT SOLAR CORONA: AN ATLAS OF 1986 K-CORONAMETER SYNOPTIC CHARTS, DECEMBER 1985 - JANUARY 1987**
D. G. Sime, C. Garcia, E. Yasukawa, E. Lundin, and K. Rock Mar. 1987 84 p
(Grant NSF ATM-82-17017)
(PB87-196382; NCAR/TN-260-STR) Avail: NTIS HC A05/MF A01 CSCL 03B

The synoptic observing project of the High Ititude Observatory's Coronal Dynamics Program began on 5 August 1980. The data obtained for it are gathered by the Mark-III K-coronameter located at the Mauna Loa Solar Observatory, Hawaii, and are published yearly in volumes of The White Solar Corona: An Atlas of K-Coronameter Synoptic Charts. The data are extended at both the beginning and the end of each volume to provide some overlap with the preceding and succeeding volumes. This is necessary to provide a complete set of the data organized into Carrington rotations covering a specific time period, since the rotations do not coincide with the yearly calendar. Further, observations are made at the limb, and west limb passage occur 14 days after the east limb passage. Thus, an entire rotation's data requires more than 28 days to collect. As well as the synoptic maps, there are two additional sections designed to aid the user included. As in previous atlases, the Activity Report Summary for the year and the Polar Synoptic Charts are included. Also included is the Mauna Loa Solar Observatory Calendar for 1986. This is a list of days on which no coronal observations were achieved. GRA

**N87-30243*#** Lockheed Missiles and Space Co., Sunnyvale, Calif.
**VERY HIGH RESOLUTION UV AND X-RAY SPECTROSCOPY AND IMAGERY OF SOLAR ACTIVE REGIONS Final Report**
M. Bruner, W. A. Brown, and B. M. Haisch 1987 63 p
(Contract NAS5-25727)
(NASA-CR-168352; NAS 1.26:168352) Avail: NTIS HC A04/MF A01 CSCL 03B

A scientific investigation of the physics of the solar atmosphere, which uses the techniques of high resolution soft X-ray spectroscopy and high resolution UV imagery, is described. The experiments were conducted during a series of three sounding rocket flights. All three flights yielded excellent images in the UV range, showing unprecedented spatial resolution. The second flight recorded the X-ray spectrum of a solar flare, and the third that of an active region. A normal incidence multi-layer mirror was used during the third flight to make the first astronomical X-ray observations using this new technique. Author

**N87-30244#** Joint Inst. for Lab. Astrophysics, Boulder, Colo.
**SOLAR OSCILLATIONS AND CONVECTIVE FLOWS AS PROBES OF STRUCTURE IN THE SUBPHOTOSPHERE Final Report, 2 Feb. 1983 - 31 Jul. 1986**
Juri Toomre and Katharine B. Gebbie 15 Apr. 1987 28 p
(Contract F19628-83-K-0008)
(AD-A183687; AFGL-TR-87-0132) Avail: NTIS HC A03/MF A01 CSCL 03B

Application of inverse theory to the observation of high-degree five-minute solar oscillations has led to the detection of horizontal flows below the solar surface that are a combination of solar rotation and giant convection cells. The distinctive displacements in the centroids of the ridges evident in the power diagrams of the oscillations from one observing day to the next arise from different patterns of giant cells being rotated into view. Such observation of frequency splittings for the high degree oscillation modes, combined with refinements in the inversion of the data using optimal averaging and spectral expansions, has shown that helioseismology should permit detailed mapping of velocity and thermal structures below the solar surface. Extensive theoretical studies of fully compressible magnetoconvection have shown that flows are indeed able to concentrate magnetic fields into concentrated flux sheets that are substantially evacuated of gas. The magnetic buoyancy instabilities have been extensively studied. GRA

**N87-30245*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**NASA'S SOLAR MAXIMUM MISSION: A LOOK AT A NEW SUN**
Joseph B. Gurman, ed. Jun. 1987 48 p
(NASA-TM-89539; NAS 1.15:89539) Avail: NTIS HC A03/MF A01 CSCL 03B

(NASA-TM-89539; NAS 1.15:89539) Avail: NTIS HC A03/MF A01 CSCL 03B

As part of the ongoing process of trying to understand the physical processes at work in the Sun, the Solar Maximum Mission (SMM) spacecraft was launched on February 14, 1980, near the height of the solar cycle, to enable the solar physics community to examine, in more physically meaningful detail than ever before, the most violent aspect of solar activity: flares. The scientific products of SMM are substantial: by 1986, over 400 papers based on SMM observations and their interpretations had appeared in scientific journals. More important than such numerical measures of success is the significance of the science that has come from SMM. The following topics, the Sun as a star, solar flares, and the active solar atmosphere, as well as other findings of SMM investigators are described. The instruments on the SMM are also described. B.G.

**N87-29555#** Joint Publications Research Service, Arlington, Va.
**INFLUENCE OF LARGE-SCALE SOLAR WIND DISTURBANCES ON DYNAMICS OF OUTER RADIATION BELT RELATIVISTIC ELECTRONS Abstract Only**
I. P. Bezrodnykh, Ye. I. Morozova, and Yu. G. Shafer *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 39 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 64-73 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29557#** Joint Publications Research Service, Arlington, Va.
**OBSERVATIONS OF RECURRENT HIGH-VELOCITY SOLAR WIND STREAMS IN DECLINING PHASE OF SOLAR ACTIVITY CYCLE 21 USING WIDE-ANGLE ION ENERGY SPECTROMETER ABOARD PROGNOZ-9 SATELLITE Abstract Only**
K. I. Gringauz, V. V. Bezrukikh, M. N. Verigin, and G. A. Kotova *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 41 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 86-92 Original language document was announced in IAA as A87-34214 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29558#** Joint Publications Research Service, Arlington, Va.
**DEPENDENCE OF SOLAR WIND VELOCITY ON DISTANCE TO HELIOSPHERIC CURRENT SHEET ACCORDING TO PROGNOZ-9 SATELLITE DATA Abstract Only**
G. A. Kotova, K. I. Gringauz, V. V. Bezrukikh, M. I. Verigin, L. A. Shvachunova, W. Riedler, and K. Shvingenshu *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 42 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 93-102 Original language document was announced in IAA as A87-34215 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

**N87-29570#** Joint Publications Research Service, Arlington, Va.
**INFLUENCE OF EXTENDED NEUTRAL ATMOSPHERE ON INTERACTION BETWEEN SOLAR WIND AND NONMAGNETIC SOLAR SYSTEM BODIES. 1: VENUS**
T. K. Breus, A. M. Krymskiy, and V. Ya. Mitnitskiy *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 77 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 124-132 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

# 93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

**N87-30246#** California Univ., Berkeley. Lawrence Berkeley Lab.
**A MEASUREMENT OF THE LOW FREQUENCY SPECTRUM OF THE COSMIC MICROWAVE BACKGROUND RADIATION Ph.D. Thesis**
S. M. Levin Apr. 1987 139 p
(Contract DE-AC03-76SF-00098)
(DE87-011212; LBL-23302) Avail: NTIS HC A07/MF A01

As part of a larger effort to measure the spectrum of the Cosmic Background Radiation (CBR) at low frequencies, the intensity of the CBR has been measured at a frequency of 1.410 GHz. The measurement was made by comparing the power received from the sky with the power received from a specially designed cooled calibration target with known properties. Sources of radiation other than the CBR were then identified and subtracted to calculate the antenna temperature of the CBR at 1.410 GHz. The instrument used to measure the CBR was a total-power microwave radiometer with a 25 MHz bandwidth centered at 1.410 GHz. The radiometer had a noise temperature of 80 K, and sufficient data were taken that radiometer noise did not contribute significantly to the total measurement error. The sources of error were predominantly systematic in nature, and the largest error was due to uncertainty in the reflection characteristics of the cold-load calibrator. Identification and subtraction of signals from the Galaxy (0.7 K) and the Earth's atmosphere (0.8 K) were also significant parts of the data reduction and error analysis. The brightness temperature of the Cosmic Background Radiation at 1.410 GHz is 222. +/- 0.55 Kelvin. The spectrum of the CBR, as determined by this measurement and other published results, is consistent with a blackbody spectrum of temperature 2.741 +/- 0.016. Constraints on the amount by which the CBR spectrum deviates from Planck spectrum are used to place limits on energy releases early in the history of the universe. DOE

**N87-30247#** Lawrence Livermore National Lab., Calif.
**MODELS OF OPTICAL AND SOFT X-RAY SPECTRA IN AM H(LC2)ER STARS**
S. H. Langer 25 May 1987 8 p Presented at the North American Workshop on Cataclysmic Variables, Aspen, Colo., 25 May 1987
(Contract W-7405-eng-48)
(DE87-011346; UCRL-96673; CONF-8705155-1) Avail: NTIS HC A02

The AM Her systems are widely believed to be cataclysmic variable systems in which the white dwarf has a magnetic field strong enough to lock the white dwarf to the companion star. The magnetic field channels the accretion flow to the magnetic polar caps of the white dwarf where the gas passes through a strong shock and the accretion energy is released. The continuum spectra of the AM Her systems have three major components: the IR/optical component, the EUV/soft X-ray component, and the hard X-ray component. Models of the AM Her systems generally agree that the hard X-rays are free-free radiation emitted by the hot postshock gas and that the optical component is electron cyclotron emission from the postshock gas. The soft X-ray component is less well understood, primarily because it is very soft (temperature less than 100 eV) and thus is very difficult to measure accurately with current instruments. Models agree that some soft X-ray emission will arise from hard X-rays and cyclotron radiation that is absorbed at the stellar surface and re-radiated, but other sources of soft X-rays have also been suggested. Thus it is important to develop models for the soft X-ray spectrum. This paper presents some preliminary results on the emission in all spectral bands based on numerical models of the accretion flow. DOE

**N87-29548#** Joint Publications Research Service, Arlington, Va.
**ANISOTROPY OF RELIC RADIATION DURING PERIOD OF SECONDARY IONIZATION OF COSMOLOGICAL HYDROGEN Abstract Only**
Ye. I. Dorosheva and P. D. Naselskiy *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 30 Transl. into ENGLISH from Astronomicheskiy Zhurnal (Moscow, USSR), v.- 64, no. 1, Jan. - Feb. 1987 p 1-14 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

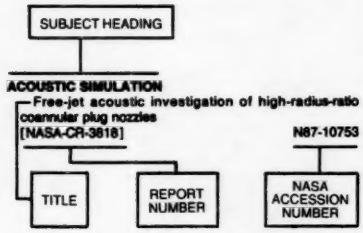
**N87-29564#** Joint Publications Research Service, Arlington, Va.
**BACKGROUND CONDITIONS FOR OBSERVING RADIO EMISSION OF ULTRAHIGH-ENERGY RADIO EMISSION PARTICLES Abstract Only**
A. T. Abrosimov, Z. Klos, S. B. Lyakhov, G. G. Managadze, Yu. V. Mineyev, W. K. Riedler, and M. F. Fridrikh *In its* JPRS Report: Science and Technology. USSR: Space 19 Aug. 1987 p 49 Transl. into ENGLISH from Kosmicheskiye Issledovaniya (Moscow, USSR), v. 25, no. 1, Jan. - Feb. 1987 p 155-157 Original language document was announced in IAA as A87-34224 (For primary document see N87-29547 24-12)
Avail: NTIS HC A08/MF A01

# 99 GENERAL

**N87-30248*#** National Aeronautics and Space Administration, Washington, D.C.
**LEADERSHIP AND AMERICA'S FUTURE IN SPACE**
Sally K. Ride Aug. 1987 64 p
(NASA-TM-89638; NAS 1.15:89638) Avail: NTIS HC A04/MF A01 CSCL 05D

In response to growing concern over the posture and long-term direction of the U.S. civilian space program, a task group was formed to define potential U.S. space initiatives, and to evaluate them in light of the current space program and the nation's desire to regain and retain space leadership. The objectives were to energize a discussion of the long-term goals of the civilian space program and to begin to investigate overall strategies to direct that program to a position of leadership. Four initiatives were identified: mission to planet Earth; exploration of the solar system; outpost on the Moon, and humans to Mars. All four initiatives were developed in detail, and the implications and requirements of each was assessed. The long-term goals, current posturing required to attain these goals, and the need for a continuing process to define, refine, and assess both the goals and the strategy to achieve them are discussed. B.G.

## Typical Subject Index Listing




The subject heading is the key to the subject content of the document. Titles, report numbers, and accession numbers of pertinent documents are provided under each subject heading. When the title is insufficiently descriptive of the document content, a title extension has been added, separated from the title by three hyphens. The report number helps to indicate the type of document cited (e.g., NASA report, NASA translation, NASA contractor report). The NASA accession number is the number by which the document abstracts are arranged in this journal and by which the document is sold or requested. The titles, with title extensions if present, are arranged under each subject heading in ascending accession number order. The subject headings have been selected from the latest revision of the *NASA Thesaurus* (NASA SP-7053).

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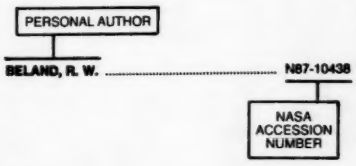


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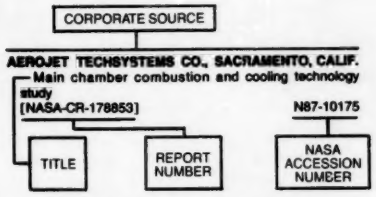


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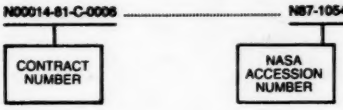


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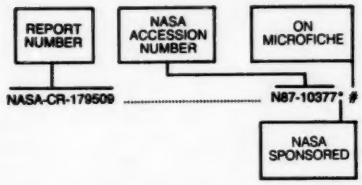


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